REVISED TREATMENT PLAN REPORT

Former Ford City Facility Slurry Lagoon Area
North Buffalo and Cadogan Townships
Armstrong County, Pennsylvania

Prepared for:

PPG Industries, Inc.
Pittsburgh, Pennsylvania

Prepared by:

CB&I Environmental & Infrastructure, Inc.
(formerly Shaw Environmental, Inc.)
Monroeville, Pennsylvania

Project Nos. 135847 and 152593
December 17, 2012
Revised January 30, 2015

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List of Acronyms & Abbreviations

°F	degrees Fahrenheit
µg/L	micrograms per liter
AMD	acid mine drainage
AO	March 9, 2009 Administrative Order
ARCADIS	ARCADIS U.S., Inc.
ASG	titanium-based arsenic-specific media
ASTM	ASTM International
Baker Environmental	Baker Environmental, Inc.
bgs	below ground surface
BV	bed volumes
CB&I	CB&I Environmental & Infrastructure, Inc.
CFR	Code of Federal Regulations
cfs	cubic feet per second
CSO	cationic exchange resin
Cummings Riter	Cummings Riter Consultants, Inc.
D’Appolonia	D’Appolonia Consulting Engineers, Inc.
Department	Pennsylvania Department of Environmental Protection
E&E	Ecology & Environment, Inc.
E&S plan	erosion and sedimentation pollution control plan
ELGs	effluent limitation guidelines
$FeCl_3$	ferric chloride
FOS	Factor of Safety
FTS	Field & Technical Services, LLC
gpm	gallons per minute
HELP	Hydrologic Evaluation of Landfill Performance
IAP	Interim Abatement Plan
IAS	Interim Abatement System
Key Environmental	Key Environmental, Incorporated
$Mg(OH)_2$	magnesium hydroxide
mg/L	milligrams per liter
amsl	above mean sea level
NPDES	National Pollutant Discharge Elimination System
O&G	oil and grease
PMFs	partial mix factors
PNDI	Pennsylvania Natural Diversity Index

List of Acronyms & Abbreviations (cont.)

POTW	publically owned treatment works
PPG	PPG Industries, Inc.
psi	pounds per square inch
PVC	polyvinyl chloride
RAOs	remedial action objectives
Report	Treatment Plan Report
RGP	Remediation General Permit
SCU	trace-metals media
~~Shaw~~	~~Shaw Environmental, Inc.~~
SLA	Slurry Lagoon Area
SPT	Standard Penetration Test
TDS	total dissolved solids
TestAmerica	TestAmerica Laboratories, Inc.
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WPC	Western Pennsylvania Conservancy
WQBELs	Water Quality Based Effluent Limitations
WQC	water quality criteria

1.0 Introduction

1.1 Purpose of Investigation

Under Performance Obligations Paragraph D (Paragraph D) of the March 9, 2009 Administrative Order (AO) issued to PPG Industries, Inc. (PPG), a Treatment Plan and schedule, which were prepared by **CB&I Environmental & Infrastructure, Inc. (CB&I), formerly** Shaw Environmental, Inc. ~~(Shaw)~~ of Monroeville, Pennsylvania, were to be submitted to the Pennsylvania Department of Environmental Protection (the "Department") on or before June 8, 2009. The Treatment Plan submitted to the Department by PPG on that date addressed the collection and treatment of "industrial waste discharges, Leachate, and seeps…" occurring at the Former Ford City Facility Slurry Lagoon in North Buffalo and Cadogan townships, Armstrong County, Pennsylvania. The Department reviewed the Treatment Plan and approved it in writing on November 9, 2011. The purpose of the investigation was to implement the various data collection activities describe in the Treatment Plan and to consider remedial alternatives that would address the requirements of the AO. This Treatment Plan Report (Report) summarizes the results of the activities that were performed in accordance with the Treatment Plan, evaluates the stability of the lagoon dikes, establishes remedial action objectives (RAOs), identifies and evaluates remedial alternatives, discusses environmental permits that may be required, and presents conclusions and recommendations regarding collection and treatment of the various water discharges in the Slurry Lagoon Area (SLA). **(Revised January 30, 2015)**

On May 13, 2014, the Department issued a letter (Comment Letter) to PPG that contained its comments regarding the Report. The Comment Letter requested PPG to submit a Revised Treatment Plan Report (Revised Report) that addressed the Department's comments. PPG subsequently submitted a Response to Comments Letter dated June 25, 2014 (Response Letter) that addressed each of the Department's comments and provided a summary of the additional investigative activities that PPG had performed to further refine the conceptual design approach to Enhanced Collection and Treatment, which was the remedial alternative recommended in the Report. A copy of this Response Letter and follow-up communications between PPG and the Department are included at the end of this Revised Report (Appendix Z) and that information is herein incorporated by reference. Please note that the attachments that were included with the Response Letter are not contained in the copy at the end of this Revised Report because they have been included herein as appendices that are appropriately referenced. The title sheets included with the Response Letter have been retained and they reference the appendix in which each document is contained in this Revised Report. (Revised January 30, 2015)

Subsequent to submitting the Response Letter, PPG requested a meeting with the Department to discuss and resolve the comments prior to submitting the Revised Report and to further discuss the additional investigative activities that had been performed. (Revised January 30, 2015)

Representatives of the Department and PPG met on July 16, 2014 to discuss the responses that were submitted on June 25, 2014, including the additional activities that had occurred since submittal of the Report. During the July 16, 2014 meeting, the Department indicated its intention to approve an Enhanced Collection and Treatment remedial approach generally consistent with that recommended in the December 17, 2012 Report. The meeting also included discussions regarding the additional activities that PPG had performed to support the Enhanced Collection and Treatment remedial approach. The Department requested an outline via email describing the next steps that would occur to enable the Department to further evaluate the Enhanced Collection and Treatment remedial alternative. On July 18, 2014, PPG submitted to the Department via email its outline along with a schedule for performing the additional evaluations. (Revised January 30, 2015)

On August 1, 2014, Cummings Riter Consultants, Inc. (Cummings Riter), on behalf of PPG, submitted a letter to the Department that addressed the items described in the above-referenced July 18, 2014 email. The Cummings Riter submittal included detailed descriptions with backup information contained in appendices of the tasks that had been completed by ARCADIS U.S., Inc. (ARCADIS), the engineering firm engaged by PPG to continue working on the development of the Enhanced Collection and Treatment remedial alternative. The submittal also presented other steps that would be taken to further address the Department's comments on the Report. These other steps included further evaluations of managing the seeps; a more detailed evaluation of the stability of the embankments on the eastern, southern, and western sides of the SLA; and identification and evaluation of methods to reduce infiltration into the SLA. Cummings Riter also indicated that summaries of other ongoing evaluations would be submitted to the Department within 60 days of the letter. (Revised January 30, 2015)

Consistent with the August 1, 2014 Cummings Riter letter, on September 3, 2014, PPG submitted via email to the Department a document titled "Former Ford City Plant – Slurry Lagoon Area Conceptual Collection and Conveyance System Description" prepared by ARCADIS. This document presented the conceptual design of the collection and conveyance system proposed for the SLA, which will consist of internal collection trenches and pumping systems installed into the source material within the SLA that will collect leachate and convey it to a treatment system for treatment and discharge. The intent of this collection and treatment system is to collect leachate before it is expressed as seeps,

thereby eliminating the leachate emanating from the existing seeps. (Revised January 30, 2015)

On September 24, 2014, PPG submitted to the Department via email two additional documents prepared by ARCADIS. These documents included an "Infiltration Reduction Conceptual Plan" and "Western Slope Seep Conceptual Plan." The infiltration reduction conceptual plan presented PPG's approach to enhancing evapotranspiration and drainage improvements on the upper surface of the SLA by revegetating remaining areas devoid of vegetation, introducing vegetative species that would enhance evapotranspiration and adsorption of precipitation, and improving drainage. The conceptual plan for the Western Slope identified and evaluated potential options to collect or eliminate those seeps. (Revised January 30, 2015)

PPG and the Department met on October 27, 2014 to discuss the submittals and subsequent activities. During this meeting, the Department indicated that the three conceptual plans prepared by ARCADIS were acceptable. Moreover, PPG and the Department agreed on the scope of work that would be performed to evaluate the stability of the slopes on the eastern, southern, and western sides of the SLA and to monitor these slopes during implementation of the Enhanced Collection and Treatment remedial alternative and for a period afterward. The Department indicated that no further comments on the Report would be forthcoming and requested that PPG provide a date for submitting the Revised Report. The Department again indicated its intent to approve the Enhanced Collection and Treatment remedial alternative and discussed permitting associated with this remedial alternative. A follow-up email to the Department confirmed discussions during the October 27, 2014 meeting. Email exchanges between PPG and the Department occurred on November 7 and November 10, 2014, clarifying remaining technical issues. In its November 10, 2014 email, PPG committed to submitting the Revised Report by January 31, 2015. (Revised January 30, 2015)

1.2 Site Description and History

The site is located in North Buffalo and Cadogan townships, Armstrong County, Pennsylvania (Figure 1). It is situated on the southern side of State Route 128 and is bounded on the east by the feature known as the Drainage Ditch (also referred to as Stream 2). The Pittsburgh and Shawmut Railroad tracks and Allegheny River form the southern boundary of the site, and Glade Run and its adjacent topographic area form the western boundary of the site.

The SLA occupies approximately 77 acres and extends for approximately 2,600 feet along the southern side of State Route 128. From north to south, the width of the SLA is approximately 1,300 feet. Ground surface generally slopes from east to west across the top of the SLA, and elevations on top of the SLA range from approximately 903 feet above mean sea level (msl) on the eastern side to approximately 892 feet msl on the western side. The total relief across the top of the site is about 11 feet. A small pond known locally as Scripps Pond is present in the east-central part of the site. The elevation of the water surface on Scripps Pond is about 898 feet msl. The SLA was closed in 1970, and in 1973, a layer of topsoil was placed and vegetation was established by planting grass seed. Currently, the site is mostly grass-covered but in some areas the grass has been succeeded by a growth of brush and trees.

The Drainage Ditch on the eastern side of the site flows southward and discharges to the Allegheny River. It carries storm water runoff from the SLA, from the baseball fields to the east, and from the topographic upland north of State Route 128. Base flow in the Drainage Ditch is comprised of groundwater discharge through the eastern dike of the SLA, groundwater discharge from the area of the baseball fields, and groundwater discharge from an area north of State Route 128. The elevation of the Drainage Ditch at State Route 128 is approximately 920 feet msl and it has an elevation of about 860 feet msl on the southeastern corner of the Slurry Lagoon. This section of the Drainage Ditch alignment has a gradient of about 188 feet per mile (approximately 3.5 percent). Pool 6 of the Allegheny River lies south of the site and has a normal pool elevation of 769 feet msl. Glade Run flows southward along the western side of the site at an elevation of about 770 feet msl and its confluence with the Allegheny River is in Pool No. 6.

The former slurry lagoons were developed in an area in which sandstone was reportedly quarried from around 1900 until 1927. The sandstone that was quarried was reportedly used by PPG to manufacture glass in their Ford City plant. In 1950, PPG obtained an Industrial Waste Permit for the disposal of grinding and polishing slurry in the quarry, which is now the SLA. The material that was conveyed to the former slurry lagoons reportedly consisted of sand, ground glass fragments, plaster, garnet, rouge (an iron oxide-based polishing agent), soda ash, and lime. Between 1953 and 1970, three former slurry lagoons were constructed within the quarry area for the management of the slurry. The former slurry lagoons are believed to have been developed by constructing earthen dikes within the quarry to contain the slurry. The approximate locations of the boundaries of the three former slurry lagoons are shown on Figure 2. Naturally occurring soil and source materials from the former slurry lagoons were reportedly used to construct the earthen dikes. The three former slurry lagoons occupy an area of about 70 acres of the 77 acres that comprise the SLA. Subsequent to the use of the former slurry lagoons for the management of the slurry, seeps developed at several locations on the outside slopes of the dikes. The locations of seeps are shown on Figure 2.

Existing conditions at the site are depicted on Figure 2. This figure shows the SLA and the locations of State Route 128, the Allegheny River, the Pittsburgh and Shawmut Railroad, and a short section of Glade Run. The locations of the seeps, the Drainage Ditch, and other site features such as Scripps Pond and the approximate boundaries of what are believed to be three separate lagoons that comprise the SLA are also shown on Figure 2. Prior to installation of the

Interim Abatement System (IAS) in compliance with the AO, the upper surface and outside of the dikes were relatively well vegetated with grass, brush, and some trees. Some small areas devoid of vegetation were present on the upper surface of the SLA and areas of the South Bench and Western Slope were also devoid of vegetation, particularly at seep locations and areas downslope of the seeps. Installation of the IAS included, among other activities, planting grass on the upper surface of the SLA in many of the small areas devoid of vegetation and at some seep locations downslope of the seeps.

During implementation of the Interim Abatement Plan (IAP), wood mulch beds were installed in areas of exposed bedrock (i.e., on the "South Bench"), on barren slopes on the southern slopes of the SLA, and at the toe of the Western Slope, where a deep bed of wood mulch was placed. As indicated, wood mulch was placed in various exposed areas. The mulch was placed to increase field capacity (and hence water retention), to reduce erosion potential, to act as an organic amendment to promote growth of volunteer vegetation, to preclude direct contact with seep water, and to act as a source of organic acids (as a result of decay) to effect leachate neutralization.

Structures to convey and treat the seep water were also installed as part of implementing the IAP. These structures included a weir bypass in the Drainage Ditch, channels, and pipes and they all convey the seep water to a mix tank for treatment via neutralization with a mineral acid in an aboveground mix tank. Repairs to fences and gates were made to further mitigate the potential for direct contact with the seeps.

IAS construction was initiated in late 2009 **pursuant to the Department's authorization letter dated July 2, 2009** and the IAS was fully operational by February 2010. The IAS has been operated and maintained since that time and continuing improvements to the system have been ongoing during its operation. Such improvements have included, but are not limited to, the collection of multiple unnamed seeps that have been identified during the course of operations. The actions taken to date to passively or actively manage the seeps via mulching or collection and neutralization have resulted in substantial improvement of the appearance of the site and have substantially reduced the discharge of high pH seep water to the Allegheny River. (**Revised January 30, 2015)**

Figure 2 also shows the locations of the various components of the IAS, including the control building where sulfuric acid is dispensed into the treatment system, the sulfuric acid storage tank, the concrete junction box, the mix tank, the weir bypass in the Drainage Ditch and associated conveyance pipe, subsurface drains that were installed to improve the efficiency of seep collection, the seep collection channel, and areas where mulch has been deployed for passive treatment of seeps.

1.3 Previous Site Investigations

Several site investigations were performed prior to issuance of the AO. The most pertinent of these investigations include work by D'Appolonia Consulting Engineers, Inc. (D'Appolonia); Dames & Moore; Ecology & Environment, Inc. (E&E); Baker Environmental, Inc. (Baker Environmental); Cummings Riter; and Key Environmental, Incorporated (Key Environmental). Beginning in 1971, D'Appolonia performed a subsurface investigation of the site which delineated the subsurface soil, bedrock, and groundwater conditions and established top of rock contours and groundwater flow directions. The results of D'Appolonia's investigation are summarized in the report "Subsurface Investigation and Study of Solid Waste Disposal Lagoon Leakage." D'Appolonia's report recommended grading and surface water management improvements as the corrective measures to address the SLA. This report was submitted to the Department in Fall 1971.

In 1984, the Department conducted inspection and sampling of the SLA in response to a citizen's complaint and found no hazard and concluded that no action was needed.

In 1991, E&E prepared a Site Screening Inspection report on behalf of the U.S. Environmental Protection Agency (USEPA) in which they identified the types of materials that were placed in the lagoons and screened environmental concerns. In February 1992, the Department issued a Notice of Violation. In response to the Notice of Violation, on behalf of PPG, Dames & Moore prepared a remedial investigation and feasibility study work plan to thoroughly characterize groundwater, surface water, soil, and bedrock conditions at the site and to evaluate the impacts of the discharges from the Drainage Ditch and seeps on human health and the environment.

In 1993, Baker Environmental modified the Dames & Moore work plan and implemented it subsequent to Department approval. Baker Environmental summarized the results of the remedial investigation in a report dated October 1993 titled "Remedial Investigation for the PPG Ford City Site." An addendum to this report was prepared in October 1994. Baker Environmental also performed a feasibility study of the site and summarized the results of the feasibility study in a June 1995 report titled "Feasibility Study for the PPG Ford City Site." PPG and Department representatives met numerous times and communicated extensively throughout the remedial investigation/feasibility study process. All three Baker Environmental reports evaluated human health and ecological risks associated with the SLA. The report concluded that there was no elevated human health risk associated with direct contact with surface soil, surface water, and sediments containing levels of arsenic above background concentrations. Further, the Baker Environmental report modeled predicted blood lead and found no predicted increase in blood lead above the 10 microgram per deciliter threshold level that was established by the USEPA. Regarding ecological risk, Baker Environmental concluded that lead concentrations in surface soil, surface water, and sediment may pose a potential risk to terrestrial invertebrates and aquatic or benthic organisms but that wetlands near Glade Run and the Allegheny River may be acting as natural treatment systems to minimize potential exposure for ecological receptors. Baker Environmental's feasibility study established RAOs for the SLA and evaluated a number of remedial alternatives based on meeting the RAOs. PPG implemented measures to address access restrictions, site restoration, and stabilization, which were the recommendations made by Baker Environmental.

In 2000, Cummings Riter performed an analysis of the stability of the dike slope in the western area of the site. The analysis included the installation of test borings and piezometers. Cummings Riter summarized the results in a report dated August 2000 and concluded that the factor of safety of the dike was in the range of 1.25 to 2.0 and that what appears to be a possible slide feature may in reality be an erosional feature. ~~Shaw~~ **CB&I** concurs with this conclusion, as discussed in Section 4.0 of this Report. **(Revised January 30, 2015)**

In 2000, Cummings Riter also developed a water balance and performed sampling in the SLA. Cummings Riter measured seepage flows, flows in the Drainage Ditch, and obtained rainfall data. Soil samples collected during the drilling for the piezometer installations, collected from the slope areas, and collected from the cap of the SLA were analyzed for a variety of parameters, including salinity. Water samples were also collected from the seeps and piezometers and essentially analyzed for the same parameters as the soils. These parameters included nitrate-nitrogen, phosphorous, potassium, sulfur, calcium, magnesium, sodium, zinc, iron, manganese, copper, organic matter, soil pH and buffer pH, soluble salts, cation exchange capacity, and base saturation. Cummings Riter summarized the results of the investigation in a report dated August 2000.

Key Environmental performed a remedial investigation and prepared a report summarizing the investigation in July 2001. Key Environmental's work was performed to confirm the efficacy of activities undertaken in response to the prior investigations and to support potential future activities at the site under Pennsylvania Act 2. The remedial investigation included compiling the history of the site, the regional and site geology and hydrogeology, a review of the wastes disposed in the SLA, a summary of previous investigations at the site, development of a hydrogeologic conceptual site model, identification and selection of constituents of interest, and an assessment of the risks associated with these constituents of interest. Key Environmental's report recommended enhanced surface water runoff from the SLA, enhanced evapotranspiration using phreatophytes, and restoring vegetation in areas of the SLA devoid of vegetation to address the SLA. As an outcome of the site investigations performed by Key Environmental, PPG submitted a Notice of Intent to Remediate under Pennsylvania Act 2.

In September 2001, Key Environmental prepared an addendum to its July 2001 remedial investigation report. The addendum report included wetlands delineation, an investigation of the subsurface soils along the South Bench, and resolved issues related to a Pennsylvania Natural Diversity Index (PNDI) search. The wetlands delineation identified a total of 20 wetland units in the study area, none of which was determined to be exceptional value. The soil sampling on the South Bench was performed to collect soil samples for analysis of constituents of interest for use in further refining the site conceptual model. The PNDI issues were investigated as part of the remedial investigation and it was concluded that no threatened or endangered species were present in the vicinity of the SLA. Key Environmental's report and addendum were approved in the October 19, 2001 letter issued by the Department.

In 2002, PPG and the Borough of Ford City entered into a Declaration of Restrictive Covenants and Access Rights regarding the SLA property.

1.4 Interim Abatement Plan

In association with the activities described in the Treatment Plan, PPG also submitted to the Department its IAP that was required under Performance Obligations Paragraph C of the AO. The IAP was to be comprised of three essential elements, including the collection and active treatment via pH adjustment of the base flow within the Drainage Ditch that forms the eastern boundary of the site, collection and active treatment via pH adjustment of most of the seeps on the South Bench, and passive treatment of other seeps on the South Bench and Western Slope via deployment of organic mulch beds. The IAS was installed in the fall of 2009 **pursuant to the Department's July 2, 2009 authorization letter** and became operational at the beginning of 2010. Since the IAS has been operating, weekly sampling and analysis of specified seeps, the treated water, the Allegheny River, and Glade Run has occurred in compliance with the AO and the approved IAP. The analytical results for the seeps and treated water samples have resulted in the accumulation of significant data on the flows and chemistries of theses water sources. These data have been evaluated as part of the implementation of this Treatment Plan and they form an important part of this Report. **(Revised January 30, 2015)**

1.5 Conceptual Site Hydrologic Model

The conceptual site hydrologic model of the SLA was initially developed by ~~Shaw~~ **CB&I** as part of the Treatment Plan based on site visits and review of geologic and groundwater information previously developed for the site. The purpose of developing a conceptual hydrologic model of the site was to provide a basis for filling information gaps during execution of the Treatment Plan and to eventually assist in identifying and evaluating potential remedial alternatives. **(Revised January 30, 2015)**

Structurally, the SLA is located on the western limb of the Duquesne-Fairmont Syncline. The axis of this structure lies approximately one-half mile east of the site. The axis of the syncline trends approximately N35°E and it forms a small elongated structural basin east of the site.

Bedrock at the site strikes approximately N35°E and dips southeast toward the Allegheny River at approximately 100 feet per mile (slightly more than one degree). The location of the site relative to the geologic structure is shown on Figure 3. The significance of dipping bedrock is that it commonly controls the direction of groundwater flow where bedrock units lie below drainage. Therefore, groundwater flow in bedrock in the SLA is expected to be to the southeast toward the Allegheny River.

Geologically, the SLA proper is a former quarry in which sandstone was reportedly mined in the early 1900s and used for manufacturing glass. Therefore, the bottoms of the former slurry lagoons are probably directly underlain by bedrock units, but some high-level glacial deposits and low-level alluvial deposits associated with the Allegheny River locally occur. The SLA is underlain by rocks of the Allegheny Group of the Pennsylvanian System. Figure 4 shows the stratigraphic interval at the site. It is likely that the Freeport and/or the Upper Worthington Sandstone units were originally quarried at the site and that the base of the SLA is founded on the Middle Kittanning Coal and/or Lower Worthington Sandstone stratigraphic units.

The SLA is generally comprised of two distinctive hydrogeologic systems: a localized shallow system that includes the immediate SLA and a deeper system in bedrock. The shallow groundwater system is limited to the immediate area of the former slurry lagoons. Topographically, the SLA is essentially a plateau that has a very gently westward sloping upper surface and steep outslopes that fall to topographically lower areas on the eastern, southern, and western sides. The northern side of the SLA is bounded by a roadside drainage channel located between State Route 128 and the northern side of the SLA. To the east, the SLA dike descends into the Drainage Ditch. To the south, the SLA dike slopes downward to the Allegheny River, and to the west, the SLA dike descends to the floodplain of Glade Run and associated wetlands. This plateau acts as its own shallow hydrologic system in that precipitation falling onto the former slurry lagoons is a major source of recharge to groundwater within the former lagoon areas. There **was** little if any run-on onto the former slurry lagoons from off-site locations **observed at the time the December 2012 Report was submitted; however, during the 2014 field investigations, ARCADIS observed that the portion of the roadside storm water channel along Route 128 on the northern side of the SLA and east of the site access road was filled in with debris and soil. As a result, runoff from the road and associated culverts appeared to sheet flow across the channel and directly into the eastern half of Lagoon 3. The steel pipe that was installed to convey runoff from the eastern half of the storm water channel to the western half was observed to be higher in elevation than the upstream invert and water could not flow in that direction. (Revised January 30, 2015)**

Groundwater in glacial deposits and bedrock units north of State Route 128 is also a source of **volumetric groundwater flux** into the former slurry lagoons. **The volumetric groundwater flux into the former lagoon** was estimated by Cummings Riter to be in the range of 5 to

9 gallons per minute (gpm), **as shown in the groundwater flux calculation brief in Appendix N**. **The information provided in Appendix N was provided to the Department in the June 25, 2014 Response Letter that addressed Comment No. 10 of the May 13, 2014 Comment Letter. (Revised January 30, 2015)**

Precipitation infiltrating the former slurry lagoons **and groundwater recharge within the subsurface** provide the primary sources of water that contribute to the ongoing seepage from the SLA and also contribute significantly to the base flow of the Drainage Ditch. ~~Groundwater~~ **Leachate** within the SLA is expected to flow radially toward the east, south, and west, discharging into the Drainage Ditch on the east and onto the slopes on the southern and western sides of the former slurry lagoons. Prior to the quarrying activities, a small westward-flowing stream was present on the northern side of the SLA, and previous studies indicated that this stream could influence the direction of groundwater flow within that part of the slurry lagoon, that is direct flow toward the Western Slope. It is not known if the quarrying activities modified the morphology of this stream, but the seeps on the Western Slope indicate a westward component of groundwater flow from the slurry lagoon. **(Revised January 30, 2015)**

It is likely that the locations at which the seeps occur are related to the manner in which the dikes of the lagoons were constructed, and the field activities described in Section 2.0 of this Report were intended in part to assist in determining if this is the case. Therefore, the shallow groundwater system at the site is primarily one in which ~~groundwater~~ **leachate** within the former slurry lagoons generally follows surface topography and discharges at locations related to the construction of the lagoon dikes. **(Revised January 30, 2015)**

Groundwater is also present in bedrock at the site, most likely in the Freeport and Upper Worthington Sandstone units that probably crop out in the northern wall of the former quarry and on the slopes below the South Bench. Groundwater is also present in deeper geologic units such as the Lower Worthington Sandstone and possibly the Kittanning Sandstone (Figure 4) as interpreted from a bedrock groundwater monitoring well installed by Baker Environmental. Assuming that groundwater in bedrock is flowing in the down dip direction, that is toward the southeast, it is possible that groundwater in the Freeport and Lower Worthington Sandstones could be discharging in the subsurface into the northern side of the closed SLA and could be a component of the groundwater present in the former slurry lagoons. Groundwater in deeper bedrock units existing below the bottom of the SLA flows southeast toward the Allegheny River. Groundwater may also be present in the isolated areas underlain by glacial deposits north of the site, and it is possible that groundwater in the glacial material may be a source of subsurface recharge into the former slurry lagoons.

1.6 Treatment Plan Activities and Remedial Alternatives

The Treatment Plan approved by the Department included a number of data collection activities that were performed to fill information gaps in the conceptual site hydrologic model. These data collection activities were performed to characterize surface water conditions; groundwater conditions; and subsurface conditions, including geological conditions, the condition of the source material within the SLA, and the stability of the dikes that form the slurry lagoon. The overall objective of the data collection activities was to develop information that would be used to evaluate viable methods for long-term mitigation of the seeps and discharges in the SLA. The following investigations comprised the data collection activities:

- Receiving stream water quality investigation
- Hydrogeologic/hydrologic investigation
- Seepage investigation
- Capillary and revegetation investigation
- Geotechnical engineering investigation

Supplemental data collection activities have been conducted since 2012 to expand upon the conceptual site model and to support assessment of remedial alternatives, and include the following:

- **Geotechnical investigation to evaluate the potential of utilizing intercepting/ dewatering trenches in the SLA as part of the Enhanced Collection and Treatment remedial alternative**
- **Bedrock lithology and bedrock groundwater quality investigation along the South Bench above the railroad track seeps to further delineate hydrological conditions in that area of the SLA**
- **Assessment of eastern Drainage Ditch pH**
- **Supplemental bench-scale treatability and settleability characterization of SLA leachate**
- **Piezometer sampling for characterization of leachate inside the source material within the SLA for treatability testing data needs**
- **Hydraulic conductivity testing of leachate in proximity to the proposed interceptor trenches**
- **Updated wetlands assessment**

Supplemental data collection activities will be conducted following this Revised Report submittal to expand upon the conceptual site model and to support development and implementation of the selected remedial alternative, some of which are discussed in

conceptual plans previously submitted to the Department (included in Appendices W, X, and Y) and include the following:

- **Additional treatability testing, as appropriate, to support the National Pollutant Discharge Elimination System (NPDES) permitting process**
- **Soil cover thickness testing and evaluation of infiltration reduction plans for the SLA surface**
- **Preparation and implementation of a soil revegetation plan of bare spots remaining on the SLA surface**
- **Evaluation of additional vegetative species introductions to the SLA surface**
- **Implementation of proposed testing for the Western Slope conceptual plan**
- **Completion of the slope stability geotechnical program**

(Revised January 30, 2015)

This Report summarizes the results of the data collection activities that were performed during implementation of the Treatment Plan **as well as supplemental investigations since 2012** and evaluates the following general remedial alternatives for mitigating seepage from the SLA as well as specific variations and combinations of these general remedial alternatives:

- No Further Action
- Continued Collection and Treatment
- Enhanced Collection and Treatment
- Infiltration Control via Capping (containment)

Other remedial alternatives are also evaluated in this Report, including leachate collection **using vertical wells**, beneficial reuse, in-situ neutralization of the leachate and/or source material, passive treatment in constructed wetlands, ex-situ treatment, excavation and disposal of the source material, and combinations of these alternatives. **(Revised January 30, 2015)**

1.7 Form of Treatment Plan Report

This Report contains a summary of the work that was performed during implementation of the Treatment Plan. Section 2.0 of this Report describes the site investigation activities performed as part of the Treatment Plan implementation **as well as supplemental investigations and data collection efforts since 2012**. Section 3.0 of this Report is a summary and evaluation of the site investigation activities and presents the analytical results of the various sampling and analysis programs that were completed as part of th**ese** investigation**s**. Section 4.0 presents a geotechnical evaluation of the dike system that forms the perimeter of the SLA. The updated site hydrologic model based on information obtained while implementing the Treatment Plan **and during**

supplemental investigations is discussed in Section 5.0. Section 6.0 presents an assessment of water quality based on an evaluation of the chemistry of the seepage water being discharged to the Allegheny River. An evaluation of effluent limitation guidelines and water treatment methods is presented in Section 7.0. RAOs are identified and remedial alternatives are evaluated in Section 8.0. Section 9.0 presents the likely required permitting for the recommended remedial alternative, and conclusions and recommendations are presented in Section 10.0. Section 11.0 is a list of references used in the preparation of this Report. **(Revised January 30, 2015)**

This Revised Report contains the information that has been developed since the original Report was submitted in December 2012, including information that was submitted in the June 25, 2014 Response Letter and follow-up communications with the Department, which are referenced in relevant sections of this Revised Report (Appendix Z). In addition to the information contained in this section of the Revised Report, the following sections of the report have been revised:

- **Section 2.0 has been revised to present a summary of the investigative activities performed by ARCADIS to refine the conceptual site hydrologic model and further evaluate the Enhanced Collection and Treatment remedial alternative.**

- **Section 3.0 has been revised to update the evaluation of the weekly seep and stream monitoring that has occurred since the Report was submitted in December 2012. It also includes an evaluation of the analytical results for water samples collected from the existing piezometers in the SLA.**

- **Section 4.0 has been revised to present the details on the additional slope stability investigation that will occur along with the proposed monitoring of the slopes on the eastern, southern, and western sides of the SLA during and after construction of the Enhanced Collection and Treatment system.**

- **The conceptual site hydrologic model in Section 5.0 has been revised to incorporate findings from two new groundwater monitoring wells that were installed toward the eastern end of the South Bench.**

- **Section 6.0 has been revised to reflect projected conditions associated with an Enhanced Collection and Treatment system and to reference anticipated discharge modeling to be performed by the Department.**

- **ARCADIS has pursued additional treatability studies of leachate collected from the existing piezometers and Section 7.0 has been revised to discuss the results of those additional studies.**

- **Section 8.0 has been revised to include a discussion of conceptual plan components of Enhanced Collection and Treatment prepared by ARCADIS that were submitted to the Department. These revisions are reflected in the Table of**

Estimated Costs for Remedial Alternatives as well as the Relative Evaluation of Remedial Alternatives section.

- **Section 9.0 has been revised to include a discussion on the NPDES permit application process and schedule.**

- **The conclusions and recommendations presented in Section 10.0 have been updated based on the conceptual plans for Enhanced Collection and Treatment.**

(Revised January 30, 2015)

2.0 Summary of Investigative Activities

This section of the Report summarizes the site investigation activities that were performed in accordance with the approved Treatment Plan to obtain information to address the identified data gaps listed in the Treatment Plan. These data gaps are summarized in Table 1 of this Report. **Supplemental investigative activities were initiated by ARCADIS in February 2014 to refine the conceptual site model and to further evaluate the Enhanced Collection and Treatment remedial alternative recommended in the December 2012 edition of this Report. These supplemental investigative activities are described in Section 2.2 and 2.4 of this Revised Report and are ongoing. (Revised January 30, 2015)**

2.1 Site Reconnaissance and Existing Conditions

Prior to implementing the activities described in the Treatment Plan, ~~Shaw~~ **CB&I** performed a reconnaissance of the site to observe existing conditions and identify locations for the piezometers, geotechnical test borings, test pits, and other sample collection locations so that identified data gaps could be appropriately investigated during the Treatment Plan implementation (Table 1). The site reconnaissance was also performed to observe site conditions as they relate to one or more of the remedial alternatives that may eventually be selected for implementation. The existing site conditions are described in the following paragraphs. **(Revised January 30, 2015)**

Existing conditions at the site are shown on Figure 2, and Figure 5 is a Site Plan that shows the overall site and features, including the SLA; seeps; Drainage Ditch; and locations of piezometers, test borings, and test pits that were installed as part of the implementation of the Treatment Plan. The SLA is comprised of the former slurry lagoons and adjacent areas to the north, east, south, and west. The SLA itself slopes from east to west at a grade of less than one percent. It presently has a relatively dense vegetative cover comprised of grass, brush, and some trees. Most of the trees are located in the undisturbed areas around Scripps Pond and in the southwestern corner of the SLA and the slope to the west, where no quarrying activities occurred. Some trees have also established themselves at other locations on top of the SLA. Prior to implementation of the IAP, a number of very small barren areas ranging from a few tens of square feet up to about 200 square feet were present on the surface of the SLA, and many of these areas were revegetated during implementation of the IAP. Due to the relatively level upper surface of the SLA and as a result of the presence of the road that provides access to the site from State Route 128, some previously delineated wetland areas and areas of standing water are present at some locations on top of the SLA. The delineated wetlands were identified in an April 2001 report by Ecological Restoration, Inc. of Apollo, Pennsylvania. That report was an attachment to Key Environmental's September 2001 Remedial Investigation Report as Addendum 1.0.

A wetland delineation and overall evaluation of the vegetative cover on top of the SLA were performed by ARCADIS in October 2014. The purpose of the delineation was to evaluate wetlands on top of the SLA previously delineated by Key Environmental in 2001 and to evaluate the overall health of the vegetative cover as part of the infiltration reduction conceptual plan. The results of the updated wetland report are discussed in Appendix Y of this Revised Report. In general, the wetland evaluation revealed that vegetation has continued to flourish on top of the SLA, bare spots have further been reduced (and a plan is being developed to further revegetate bare spots), and several of the smaller individual wetlands have merged into fewer, but larger extended wetlands on the SLA surface. (Revised January 30, 2015)

The northern boundary of the SLA is adjacent to State Route 128. At the gate leading to the access road into the site, the top of the SLA is very nearly at road level, but the roadway falls in elevation toward the west and a roadside surface water diversion channel separates the SLA from Route 128. Ground surface elevations on top of the SLA along the northern border are in the range of 892 to 910 feet msl. Two visually identified seeps are present on the north-facing slope above the roadside drainage channel. Visual inspection of these seeps suggests that they flow intermittently and that the presence of water emanating from the slope is controlled by the elevation of the water table within the SLA. These seeps discharge to the surface water channel adjacent to State Route 128. Water carried in this channel flows into a mulch treatment bed installed near the toe of the Western Slope as part of the IAP.

As observed during the 2014 field investigations, the portion of the roadside storm water channel along Route 128 on the northern side of the SLA and east of the site access road has filled in with debris and soil. As a result, some runoff from the road and associated culverts appears to sheet flow across the channel and directly into the eastern half of Lagoon 3. The steel pipe that was installed to convey runoff from the eastern half of the storm water channel to the western half is higher in elevation than the upstream invert and no water flows in that direction. (Revised January 30, 2015)

The Drainage Ditch, a feature with well vegetated side slopes that forms the eastern boundary of the site, is located in a steep-sided valley up to ~~approximately~~ 30 feet deep. The defined headwater of the Drainage Ditch begins at State Route 128 although the drainage area extends north of State Route 128. This drainage feature trends southward and becomes incised into its well defined valley approximately 500 feet south of State Route 128. Runoff from the area north of State Route 128 discharges to the Drainage Ditch through a culvert beneath State Route 128. **Based on recent observations, it appears that some storm water runoff in the northeastern**

portion of the SLA may also flow toward and discharge into the Drainage Ditch. Seep 105 is the only identified seep that discharges into the Drainage Ditch. The base flow in the drainage ditch is currently collected and conveyed to the IAS where it is treated by adjusting the pH prior to being discharged. The weir bypass structure was constructed in the Drainage Ditch as part of the IAS. Flow in excess of the base flow in the Drainage Ditch is routed through the flume in the weir bypass structure and discharged directly to the Allegheny River. **(Revised January 30, 2015)**

The South Bench, a gently sloping area on the southern side of the SLA, forms the southern boundary of the site below the southern dike of the slurry lagoon. It generally slopes from west to east, having an elevation of about 880 feet msl on the western end and 850 feet msl on the eastern end. Seeps SE, 102, 103, 100, 108, 110, 109, 101, 104, 4, 5, and Seep S discharge on the South Bench but have been collected for treatment in the IAS. As a result of implementing the IAP, a number of improvements have been made to the South Bench including the installation of the riprap-lined channel to collect Seeps 100, 108, and 110; collection of some unnamed seeps in subsurface drains for conveyance to the neutralization system; placement of mulch to passively treat Seeps 102, SE, S, 4, 101, 104, and 109; collecting Seep 103 for treatment in the IAS and tying the base flow of Seep 5 into the IAS for pH adjustment; construction of a roadway to provide access to the IAS junction box and mix tank; and revegetation of the areas that were disturbed during construction of the IAS.

The Western Slope forms the western boundary of the SLA and has a slope in the range of approximately two horizontal to one vertical (2H:1V) to 3H:1V. Ground surface elevations at the top of the slope are in the range of 890 feet msl to 900 feet msl and at the bottom of the slope, the ground surface elevation is about 780 feet msl. Two shallow erosion swales have developed at the top of the Western Slope and runoff in these swales has created two erosion channels on the slope below the top of the slurry lagoon. The more significant of these two erosion channels is lined with riprap at the top of the slope. The base of the Western Slope is on or just above the floodplain of Glade Run. Seep 106 emanates on the slope approximately 20 feet below the top slurry lagoon, and Seeps 6 and W are present at the bottom of the slope. These seeps flow to an area in which a mulch bed was constructed as part of the IAP implementation where they are passively treated. Water has never been observed to emanate from the mulch bed once it was constructed.

2.2 Treatment Plan Site Investigation Activities

Implementation of the Treatment Plan involved the following activities **that were performed from 2009 to 2011 to support the preparation of the December 2012 Report**:

- Installation of 13 piezometers within the SLA

- Drilling of four geotechnical test borings and performance of a geotechnical evaluation of the slurry lagoon dikes
- Excavation of 16 test pits
- Performing a water quality investigation of the Allegheny River and Glade Run
- Analyses of source material samples collected from the test borings for the piezometers
- Collecting and analyzing samples of ponded water and runoff from the SLA
- Collecting and analyzing samples of talus
- Performing a revegetation study and obtaining agronomic analyses of soil samples

Supplemental data collection activities have been conducted since 2012 to expand upon the conceptual site model and to support assessment of remedial alternatives, and include the following:

- **Geotechnical investigation to evaluate the potential of utilizing intercepting/ dewatering trenches in the SLA as part of the Enhanced Collection and Treatment remedial alternative**
- **Bedrock lithology and bedrock groundwater quality investigation along the South Bench above the railroad track seeps to further delineate hydrological conditions in that area of the SLA**
- **Assessment of eastern Drainage Ditch pH**
- **Supplemental bench-scale treatability and settleability characterization of SLA leachate**
- **Piezometer sampling for characterization of leachate inside the source material within the SLA for treatability testing data needs**
- **Hydraulic conductivity testing of leachate in proximity to the proposed interceptor trenches**
- **Updated wetlands assessment**

Each of the~~se~~ **above** activities is described in greater detail in the following sections. **Ongoing activities beyond the scope of the Treatment Plan that have not yet been completed include additional treatability testing, additional slope stability evaluations, refinement of the infiltration reduction and Western Slope conceptual plan components. The results of these ongoing activities will be used to support implementation of the selected remedy. (Revised January 30, 2015)**

2.2.1 Piezometer Installations (2009-2011)

A total of 13 piezometers were installed within the SLA by Terra Testing of Washington, Pennsylvania. The piezometers were installed to obtain samples of the source material for analysis and to obtain depth-to-~~groundwater~~ **leachate** measurements within the former slurry lagoons. The locations of the piezometers are shown on Figure 5, and copies of the drilling logs that describe the material encountered are contained in Appendix A. The logs also show the piezometer installation details. Coordinates and elevations of the 13 new piezometers are shown on Table 2. Also shown on Table 2 are the coordinates and elevations of the test borings, previously installed monitoring wells, and piezometers. The piezometers have been numbered to be in consecutive order with piezometers that were installed during previous investigations at the site and are designated PZ-7 through PZ-19. Four of the piezometers (PZ-8, PZ-11, PZ-13, and PZ-16) were installed for the purpose of encountering and characterizing the earthen dikes that are believed to have been constructed to separate the former slurry lagoons in order to confirm their locations as shown on the Site Plan. **(Revised January 30, 2015)**

Installation of the piezometers involved drilling the test borings with a geotechnical drill rig. The boreholes were advanced by performing continuous split-barrel sampling and by advancing the test borings between sampling intervals using 8.25-inch outside diameter hollow-stem augers. Each test boring was advanced to refusal on the top of bedrock at the bottom of the former slurry lagoons or at the bottom of the earthen dikes that separate the former slurry lagoons. Split-barrel samples were collected in accordance with ASTM International (ASTM) Method D 1586. Samples were obtained using the Standard Penetration Test (SPT). The SPT consists of raising and dropping a 140-pound hammer 30 inches and counting the number of blows required to advance the split-barrel sampler three successive 6-inch intervals. The number of blows required to drive the split-barrel sampler the final two 6-inch intervals for each sampling interval is designated as the Penetration Resistance. The Penetration Resistance is a qualitative measure of the in-place consistency of cohesive materials or the in-place relative density of granular materials. After each split-barrel sample was collected, it was placed in a glass jar with a water-tight lid and logged by ~~Shaw~~**CB&I**'s scientist. The materials encountered in the test borings soils were logged by describing their color, grain size distribution, relative moisture, and the density or consistency. Samples collected during the SPT indicate that the source materials are comprised of non-plastic silt having an in-place density ranging from medium dense to very dense. **(Revised January 30, 2015)**

After refusal was reached in each test boring, a piezometer was installed. The piezometer installation consisted of placing an appropriate length of flush-thread, two-inch diameter Schedule 40 polyvinyl chloride (PVC) well screen having 0.01-inch wide slots into the borehole and then placing a piece of solid two-inch diameter PVC riser pipe to extend approximately two feet above ground surface. The annular space around the slotted section of well screen was filled with sand to a level approximately two feet above the well screen and then a bentonite pellet seal was installed to ground surface. The bentonite seal was hydrated using potable water provided by the drilling contractor. Each piezometer was completed by installing a four-inch diameter steel protective casing with a locking cap and constructing a concrete pad around the protective casing at ground surface. The piezometers were developed by bailing a minimum of three well volumes of water and measuring pH, specific conductance, and temperature until consistent readings were obtained. The locations and elevations of the piezometers were then surveyed by a Pennsylvania-licensed surveyor.

Upon completing the piezometer installations, a depth-to-groundwater measuring program was initiated. Water levels in the piezometers were measured weekly for the first four weeks after the piezometers were installed and monthly thereafter. Water levels were measured in the piezometers from June 25, 2009 through June 20, 2011. Table 3 is a summary of the water level measurements obtained in the 13 new piezometers as well as existing Piezometers P-1, P-2, and P-3 which are located on top of the SLA above the South Bench; existing **groundwater levels were measured in** Monitoring Wells MW-13 and MW-14, which are located on the South Bench. **(Revised January 30, 2015)**

In conjunction with measuring the water levels in the piezometers, a rain gauge was installed at the site at the location shown on Figure 6. The rain gauge was used to collect rainfall information to support and confirm the site hydrologic model. The rainfall information was obtained from June 17, 2009 through June 24, 2011 and is summarized on Table 4. Groundwater levels within the SLA, seep discharges, and rainfall data are discussed in Section 5.0 of this Report. **(Revised January 30, 2015)**

2.2.2 Geotechnical Test Borings and Geotechnical Engineering Investigation (2009-2011)

Four test borings were drilled to assess the geotechnical properties of the material comprising the dike on the south side of the SLA and to install piezometers to delineate the groundwater table within the dikes. The locations of the test borings are shown on Figure 5, and copies of the drilling logs that describe the material encountered and showing the piezometer installation details are included in Appendix A. Test Borings TB-1, TB-3, and TB-5 were drilled on top of the dike and Test Boring TB-6 was drilled on the South Bench below TB-5. Two other test borings, TB-2 and TB-4, were scheduled to be drilled and converted to piezometers but were eliminated from the drilling program due to the very shallow depth to bedrock at their proposed locations on the South Bench. Piezometers were installed in Test Borings TB-1, TB-3, and TB-5 but not in TB-6 because of the shallow depth to bedrock and the presence of groundwater at ground surface at the location of TB-6.

The test borings were drilled in the same manner as the test borings for the piezometers. Continuous split-barrel samples were obtained from ground surface to refusal on the upper bedrock surface. The SPT was utilized for all of the sampling except that Shelby tube samples were collected in Test Borings TB-1, TB-3, and TB-5 in order to obtain undisturbed samples for laboratory testing of the geotechnical properties of the materials comprising the dikes. The piezometers were also installed in the same manner as the piezometers installed in the SLA. Coordinates and elevations of the test borings are summarized on Table 2. Water levels measured in the piezometers between June 25, 2009 and May 20, 2011 are summarized on Table 3.

Shelby tube samples from TB-1, TB-3, and TB-5 were analyzed for a variety of geotechnical properties to support a slope stability analysis of the dike and to provide additional information for the hydrogeologic model of the SLA. The samples were analyzed for routine index properties including grain size distribution and plasticity index and for permeability and shear strength. The test results are summarized on Table 5 and the laboratory reports are contained in Appendix B.

2.2.3 Test Pits (2009-2011)

A total of 16 test pits were excavated at locations on top of the SLA, on the South Bench, and on the Western Slope. The purpose of the test pits was to determine the depth to the source material, the thickness of the topsoil zone on top of the SLA, and the type and thickness of soil on the South Bench in order to evaluate the potential for successful revegetation of these areas. The locations at which the test pits were excavated are shown on Figure 5 and test pit logs are contained in Appendix A.

Test Pits TP-1 through TP-7 were excavated on top of the SLA and Test Pits TP-8 through TP-16 were excavated on the South Bench and on the talus bench below the South Bench. The test pits excavated on top of the SLA ranged in depth from about 4 to 5.5 feet. The depth to the source material ranged from about one inch to about six inches; that is, the topsoil zone was one to six inches thick and had an average thickness of about four inches. The test pits excavated on the South Bench and talus slope ranged in thickness from about 0.5 foot to about 8 feet but most were only excavated to a depth of about 2 feet where bedrock was encountered.

2.2.4 Receiving Streams Water Quality Investigation (2009-2011)

The objective of the water quality investigation data collection efforts was to investigate and evaluate, on a “snapshot” basis, the flow conditions and water chemistry within the Allegheny River and Glade Run to determine if there have been adverse impacts from the site. To that end, the following activities were performed during this part of the investigation:

- Surface water samples were collected from the Allegheny River at five transect locations at distances of 10 feet, 25 feet, and 50 feet from the northern bank. The locations of these transects are shown on Figure 6. The transects were located upstream of the site (Sample Series AR-1), just downstream of the primary seep discharge location (Sample Series AR-2), downstream of the primary seep discharge location adjacent to the Gateway (Sample Series AR-3), upstream of Glade Run (Sample Series AR-4), and downstream of Glade Run (Sample Series AR-5). The transect locations were marked using stakes (on the shoreline), and locations were documented using a hand-held global positioning system instrument. The samples were analyzed for pH; specific conductance; total alkalinity; total dissolved solids (TDS); and total concentrations of aluminum, arsenic, chromium, iron, antimony, and lead. Table 6 contains a summary of the analytical results and the laboratory reports are contained in Appendix C.

- Surface water samples were collected from Glade Run as center-stream grab samples downstream of the site at the confluence with the Allegheny River (Sample No. GR-1), adjacent to the site (Sample No. GR-2), and upstream of the site (Sample No. GR-3). The sample locations are not shown on Figure 6 because they are beyond the area covered by the topographic mapping. Samples were analyzed for pH; specific conductance; total alkalinity; TDS; and for total concentrations of aluminum, arsenic, chromium, iron, antimony, and lead. Analytical results for the Glade Run samples are summarized on Table 6 and the laboratory reports are contained in Appendix E.

Water samples in Glade Run and the Allegheny River were collected in laboratory-supplied containers having appropriate preservatives. Standard sampling protocols were followed during sample collection activities including the use of new or properly cleaned containers, proper labeling of sample containers, completion of chain-of-custody forms, proper packaging of sample containers, and storing collected samples in coolers containing ice packs for delivery to the analytical laboratory. One duplicate sample was also collected for analysis as a quality assurance/quality control check. The samples were transported each day they were collected to the TestAmerica Laboratories, Inc. (TestAmerica) in Pittsburgh, Pennsylvania.

Comment No. 12 in the May 13, 2014 Comment Letter requested PPG to revise the Report to include the conditions under which the water quality samples in the Allegheny River and Glade Run were collected so that the seep flows and stream flows can be compared in the assessment of impacts. In the June 25, 2014 Responses Letter, PPG clarified that measurements of flows and collection of samples for chemical analysis in the Allegheny River and Glade Run have occurred weekly in accordance with the March 9, 2009 AO. The results of this monitoring have been reported to the Department monthly. The weekly monitoring has resulted in the development of an extremely robust data set that covers a variety of flow conditions in the Allegheny River and Glade Run. (Revised January 30, 2015)

2.2.5 Source Material Analysis (2009-2011)

Samples of source material were selected for analysis from the split-barrel samples collected during drilling for the installation of the piezometers. A total of 24 samples of source material have been analyzed for aluminum, arsenic, chromium, iron, sodium, lead, pH, and total alkalinity. Three samples were analyzed from each of eight selected piezometer test borings to obtain a profile of the chemical characteristics of the source material with depth. The locations of the piezometers are shown on Figure 6, and Table 7 contains information on the depths of samples selected for analysis. Table 7 also contains a summary of the analytical results. The samples were analyzed by TestAmerica of Pittsburgh, Pennsylvania. The laboratory reports are contained in Appendix D.

2.2.6 Ponded Water and Storm Water Runoff Samples (2009-2011)

Four samples of water were collected from areas of standing water (ponded water) on top of the SLA and two samples of storm water runoff were collected for analysis. The purpose of analyzing ponded water and runoff water samples was to evaluate whether these waters have been impacted by the source materials at the site. The ponded water samples are designated as PW-1, PW-2, PW-3, and PW-4 and the locations at which these samples have been collected are shown on Figure 6. The two storm water runoff samples are designated Runoff-1 and Runoff-2 and the locations at which they were collected are also shown on Figure 6. The four ponded water samples and two storm water samples were analyzed for pH; specific conductance; total alkalinity; TDS; and total and dissolved aluminum, arsenic, chromium, iron, lead, and antimony. A duplicate ponded water sample was also obtained and analyzed for the above-listed constituents. The results of the ponded water samples are shown in Table 8 and the laboratory reports are contained in Appendix E. The ponded water and runoff samples were analyzed by TestAmerica of Pittsburgh, Pennsylvania.

Generally, the upper surface of the SLA slopes from east to west and storm water runoff is generally toward the Western Slope. For this reason, sample Runoff-1 was collected near the top of the Western Slope where runoff discharges via sheet flow toward Glade Run. Toward the eastern side of the SLA, runoff discharges to the Drainage Ditch and sample Runoff-2 was collected in the Drainage Ditch near its junction with the South Bench.

2.2.7 Talus Samples (2009-2011)

A total of three talus samples were collected on the slope below the South Bench to evaluate this material as a potential secondary source that could adversely impact the quality of water that comes into contact with it. The talus is essentially comprised of naturally occurring soil and precipitate that formed downslope of some of the seeps. The locations of the talus samples, designated Talus-1, Talus-2, and Talus-3, are shown on Figure 6. The samples were analyzed for aluminum, arsenic, chromium, iron, sodium, lead, antimony, pH, and total alkalinity. The analytical results are shown on Table 9 and the laboratory reports are contained in Appendix F.

2.2.8 Revegetation Test Plots and Agronomic Analyses (2009-2011)

In order to evaluate the potential for successful revegetation of areas barren of vegetative cover on top of the SLA, the South Bench, and the Western Slope, which are areas of highly alkaline and saline soils, a series of seven test plots, labeled RTP-1 through RTP-7 were developed at the locations shown on Figure 6. Each test plot was prepared by scarifying the barren ground surface with the teeth on a backhoe bucket prior to planting. Elemental sulfur was added as a soil amendment to RTP-2, RTP-4, and RTP-7 and to approximately half of RTP-5 in order to provide a lower-pH substrate to improve the likelihood of successful germination of the grass seed. After the test plots were prepared, they were planted with seven different species of grass seeds to determine if they would germinate and thrive in alkaline and saline conditions. Hand-drawn sketches of the test plots with a list of grass seed species planted are included in Appendix G.

Soil samples from five of the test plots (RTP-1, RTP-2, RTP-3, RTP-4, and RTP-6), two test pits (TP-2-B and TP-4-B), and one surface sample (STP-2-B) were collected and shipped to the Pennsylvania State University Agricultural Analytical Services Laboratory for analysis of fertilizer requirements. The results of the soil analyses are shown on Table 10 and the laboratory reports are also contained in Appendix G.

In association with developing the test plots, tensiometers were installed at six test plot areas (RTP-1 through RTP-6) to measure capillary rise of water within the test plot area in order to evaluate the potential for alkaline and saline water to impact the grass species that have been planted. The measured tensiometer characteristics are summarized on Table 11. As shown on Table 11, the tensiometers were visually monitored from August 20, 2009 through September 29, 2009 to determine if water was present in them, indicating capillary rise of groundwater from the subsurface, the pH of water present in the tensiometers, and the appearance of any water present in the tensiometers.

2.2.9 New Test Borings and Groundwater Monitoring Wells (2014)

Supplemental site investigation activities were initiated by ARCADIS in February 2014. These investigative activities consisted of drilling 37 geotechnical test borings on the southern and eastern sides of the SLA and installing two new groundwater monitoring wells on the eastern end of the South Bench. ARCADIS drilled a total of 37 test borings along the alignment of the interceptor trenches proposed for the eastern and southern sides of the SLA. All 37 test borings were drilled using hollow-stem augers. Continuous split-barrel sampling was performed in each test boring from ground surface to the final depth on top of bedrock. The test borings were logged by an ARCADIS geologist who described the materials encountered including the color, grain size distribution, and relative moisture. Samples collected during the SPT indicate that the source materials are

comprised of non-plastic silt having an in-place density ranging from medium dense to very dense. ARCADIS prepared a summary of the drilling activities that is contained at the end of Appendix A. This summary was previously submitted to the Department with the June 25, 2014 Response Letter and it includes the test boring logs, Site Plan showing cross section locations, including the test boring locations as Figure 1, and Figure 2 – Interceptor Trenches – South and East Seep Control Cross Sections G-G' & H-H'. (Revised January 30, 2015)

For the purpose of further evaluating the conceptual site model of groundwater in bedrock described in Section 5.1.3 of the Report, ARCADIS installed two new side-by-side groundwater monitoring wells on the eastern end of the South Bench. These two groundwater monitoring wells, designated MW-20 and MW-21, were installed at the locations shown on Figure 1 at the end of Appendix A. The test boring logs showing the well installation details are also included at the end of Appendix A. Monitoring Well MW-20 was installed to a depth of 65 feet below ground surface (bgs) and was intended to determine the depth to groundwater deeper in bedrock. MW-21 was installed to a depth of 40 feet and was intended to determine the depth to shallow groundwater in bedrock. Fifteen feet of slotted 2-inch diameter polyvinyl chloride well screen were installed in each groundwater monitoring well. Depth to groundwater was measured from 20.11 to 20.68 feet in MW-20 from March through July 2014; the results are summarized in Section 3.9 and are also discussed in Section 5.1.2. (Revised January 30, 2015).

2.2.10 Eastern Drainage Ditch pH Assessment (2014)

In March and April 2014, ARCADIS collected field pH measurements from 35 surface water locations and 4 piezometers along the eastern Drainage Ditch to delineate the origin of seep water discharges causing pH levels above 9.0 standard units to the Drainage Ditch surface water. Duplicate pH measurements were taken at each sample location and values ranged from 7.9 to 11.8 standard units. Results of this analytical program are shown graphically on Figure 3 in Appendix Q and are summarized in Section 3.8. (Revised January 30, 2015)

2.2.11 Phase I Treatability Study (2014)

The Enhanced Collection and Treatment remedial alternative that was described in Section 8.3.3 of the December 2012 Report has been further evaluated by ARCADIS to determine if intercepting the leachate within the SLA prior to it being expressed at the seep locations is a viable and better alternative than collecting the leachate at the seep locations. The evaluation considered installation of interceptor trenches internal to the SLA. An important component of evaluating the viability of installing internal interceptor trenches was determining the chemistry of the leachate that would be collected in this system from

the treatability perspective. Expanding on the treatability testing described in the December 2012 Report, a Phase I treatability testing study was performed in March 2014 to evaluate treatment of leachate that would be collected in the interceptor trenches. The March 2014 Phase I Treatability Testing results are discussed in Section 7.4 of this Revised Report and analytical results summarized in Appendix R. (Revised January 30, 2015)

2.2.12 Phase II Treatability Study Leachate Characterization (2014)

In May 2014, leachate samples were collected from 10 existing piezometers (PZ-1, PZ-2, PZ-3, PZ-6S, PZ-7, PZ-8, PZ-9, PZ-15, PZ-16, and PZ-17) in the SLA. PZ-4 was scheduled to be sampled but was dry prior to purging. The sampling was performed for the Phase II treatability study to support the design of the water treatment system (if required) and provide representative samples of the leachate for the supplemental bench-scale treatability testing discussed in Section 7.4 of this Revised Report. Prior to sampling, piezometers were redeveloped to remove suspended solids and to ensure they were hydraulically connected to the source material. Leachate sampling was conducted via low-flow sampling methods to ensure laminar flow conditions prevailed during the sampling process. (Revised January 30, 2015)

Leachate samples were submitted to TestAmerica for analysis of pH, total and dissolved metals and silica, total and dissolved organic carbon, wet chemistry parameters (including, but not limited to, ammonia, kjeldahl nitrogen, ortho-phosphate, alkalinity, and total suspended and dissolved solids), chemical and biological oxygen demand, and field parameters (pH, oxidation-reduction potential, temperature, dissolved oxygen, specific conductance, and turbidity). Analytical results for the leachate sampling event are contained in Appendix S along with a description of the sampling protocols that were followed, and they are further summarized in Section 3.7. It is evident that the chemical characteristics of the leachate (dissolved metals and silica) differed from those of the seep water previously tested. In general, the leachate water proved to have lower metals concentrations but higher silica concentrations as compared to the seep water metals and silica concentrations. (Revised January 30, 2015)

2.2.13 Phase III Treatability Testing (2014)

As will be discussed in Section 7.4 of this Revised Report, the results of the Phase I and Phase II treatability studies indicated the need to continue treatability testing to further determine metals removal efficiency and to further study effective means of managing precipitates that form during the precipitation process. ARCADIS performed this Phase III testing as a continuation of the overall precipitation technologies treatability testing. (Revised January 30, 2015)

2.2.14 Hydraulic Conductivity Testing (2014)

In February 2014, hydraulic conductivity was measured in seven piezometers (PZ-1, PZ-2, PZ-3, PZ-7, PZ-9, PZ-12, and PZ-17) screened within the SLA, with piezometer selection biased to be in close proximity to the proposed interceptor trench and in one piezometer screened in the glacial till material located outside the SLA (PZ-15). Hydraulic conductivity was measured via rising and falling head tests (slug tests). Slug test data were evaluated using Aquasolve software, and conductivity values were calculated using Bouwer-Rice methodology. The assessment was intended to support the screening of remedial approaches and refine the conceptual site model. Results of the hydraulic conductivity tests are contained in Appendix T and are discussed in Section 5.1.1. (Revised January 30, 2015)

2.3 Seepage Evaluation (2009-2014)

Paragraph A under the Performance Obligations of the AO requires weekly monitoring of the seeps, the Drainage Ditch (also referred to as Stream 2), the Allegheny River, and Glade Run. The monitoring includes flow, total suspended solids (TSS), oil and grease (O&G), iron, aluminum, lead, chromium, antimony, arsenic, and pH. Field & Technical Services, LLC (FTS) of Carnegie, Pennsylvania, performs the weekly monitoring on behalf of PPG and the results are reported to the Department monthly in accordance with the AO. FTS also operates and maintains the IAS and the results of the treated water monitoring are reported monthly to the Department. Monitoring of the seeps, Drainage Ditch, Allegheny River, and Glade Run has been ongoing since April 6, 2009 and the information obtained through this monitoring allows the seepage from the SLA to be evaluated in terms of flow and chemistry. The weekly monitoring information collected by FTS is contained in Appendix H and it includes four sets of tables including Table 1, Flow Measurement Summary; Table 2, Seep Flow Measurement Summary; Table 3, Glade Run Flow Measurement Summary; and Table 4, Analytical Data.

The weekly monitoring information developed by FTS was reviewed and evaluated to determine the quantity of water discharging from the site. This information is necessary in order to confirm or revise the conceptual site hydrologic model that was presented in the Treatment Plan. Moreover, the seepage evaluation is a necessary component of evaluating remedial alternatives because remedial alternatives consider both the quantity of seepage and the chemistry of the seepage.

The weekly seepage information, including flow in the Drainage Ditch and the seeps emanating on the South Bench and Western Slope were evaluated with respect to quantity of flow. Based on a total of ~~169~~**299** weekly monitoring events between April 6, 2009 and ~~July 31, 2012~~**December 30, 2014**, the maximum flow from the seeps and Drainage Ditch was approximately 580 gpm on May 8, 2012 and the minimum flow was **0** gpm on January **28, 2014**

but the absence of flow was attributed to freezing conditions. The average flow from the seeps named in the AO and the Drainage Ditch ~~is~~**appeared to remain at approximately** 29 gpm **throughout the monitoring period, based on a qualitative evaluation of the data**. The average discharge from the drainage channel along the Pittsburgh and Shawmut Railroad tracks was determined through flow measurements in the culverts into which the drainage channel discharges to be approximately 8 gpm as measured during the period April 27, 2012 through October 2012. Therefore, the average seepage rate from the SLA **remained at** ~~determined to be~~ approximately 37 gpm. This average flow provides a basis for comparison with seepage rates calculated by the Hydrologic Evaluation of Landfill Performance (HELP) model which is discussed in Section 5.0 of this Report. Section 5.0 describes the site hydrologic model, and the results of the HELP model are part of that review. **(Revised January 30, 2015)**

The IAS, which was placed into operation in January 2010, included active collection and treatment of the base flow from the Drainage Ditch (which captures the flow from Seep 105) and the discharge from Seeps 100, 103, 108, and 110 on the South Bench. Seeps 4, 100, 101, 102, 104, S, and SE were directed to mulch beds placed at strategic locations for passive treatment as were Seeps 6, 106, and W on the Western Slope. In August 2012, the Seep 5 base flow of 5 gpm was directed to the active treatment system for pH adjustment. Other seeps identified after implementation of the IAP have been collected for active treatment. Collection of other seeps downslope of the IAS treatment system is also being considered. As will be discussed in Section 6.0, the metals concentrations in the water being treated by the IAS and the metals concentrations of the water from Seep 5 were utilized to determine the average concentrations of the six metals that are being monitored in the Outfall 001 discharge water as required under the AO. These metals include aluminum, antimony, arsenic, chromium, iron, and lead and are taken into consideration in evaluating remedial alternatives for the SLA.

An NPDES permit **will** ~~may~~ be obtained to ultimately replace the AO as the basis for continued authority to discharge treated water ~~(if any)~~ into the Allegheny River. Water Quality Based Effluent Limitations (WQBELs) that might be incorporated into the NPDES permit were evaluated by constructing the PENTOXSD model. ~~Shaw~~**CB&I** utilized the weekly chemistry information for water treated by the IAS and discharged at Outfall 001 and for Seep 5 to calculate the flow-weighted average concentrations for the following six metals that are addressed in the AO:

- Aluminum
- Antimony
- Arsenic
- Chromium
- Iron
- Lead

These six metals are also being analyzed in the samples collected weekly from the seeps, consistent with the requirements of the AO. A discussion of the PENTOXSD model results and the implications of the model results with respect to remedial alternatives, including on-site treatment and discharge is contained in Section 6.0 of this Report. **(Revised January 30, 2015)**

2.4 Surface and Subsurface Conditions

Data gaps that were identified in the Treatment Plan relating to surface and subsurface conditions in the SLA are listed on Table 1. Implementation of the Treatment Plan required, among other things, addressing data gaps in order to fully understand the site hydrologic model and to assist in evaluating remedial alternatives. This section presents a summary of the ~~subsurface conditions as they relate to the following identified~~ **work undertaken to address those** data gaps:

- **Evaluate the** depth to and type of bedrock underlying the former slurry lagoons
- Evaluate the presence of glacial deposits in the area immediately north of the SLA and the potential for these deposits to be a source of groundwater recharging the former slurry lagoons
- Determine the composition, thickness, and geotechnical properties of the materials comprising the outer dikes of the former slurry lagoons and the natural slopes below the South Bench
- Determine the depth to and type of bedrock underlying the slurry impoundment dike above the South Bench, depth to and type of bedrock underlying the South Bench, and the extent to which geological conditions may be contributing to the formation and presence of seeps on the South Bench
- Determine if groundwater exists within the outer slurry lagoon dikes
- Determine the depth to and configuration of the phreatic surface within the three former slurry lagoons and the direction of **leachate**~~r~~ flow
- Confirm the presence and locations of the internal dikes that reportedly separate the three former slurry lagoons, thickness and composition of the materials comprising these internal dikes, and depth to groundwater within these dikes
- Assess the relationship between groundwater flowing along the soil/bedrock interface and in the uppermost part of fractured bedrock along the eastern end of the South Bench and groundwater deeper in bedrock.

Addressing the above-listed data gaps involved installing 13 piezometers in the SLA, drilling four standard geotechnical test borings, and excavating 16 test pits. **Two new groundwater monitoring wells, MW-20 and MW-21, were installed on the eastern end of the South Bench to assist in delineating groundwater conditions in that area of the SLA.** The following evaluation of subsurface conditions is based on information obtained from the installation of the piezometers, geotechnical test borings, ~~and~~ test pits, **and monitoring wells**. **(Revised January 30, 2015)**

2.4.1 Slurry Lagoon Subsurface Conditions

Subsurface conditions in the SLA were ~~determined~~ **assessed by CB&I under the Treatment Plan** through the drilling of 13 test borings in which piezometers were installed and by excavating seven test pits (TP-1 through TP-7) at selected locations. The locations of the piezometers that were installed into the former slurry lagoons are shown on Figure 7 as are the locations of the test pits. Six geological cross sections were constructed to depict the subsurface conditions in the SLA, including Geologic Cross Sections A-A', B-B', C-C', D-D', E-E', and F-F'. The plan locations of the geologic cross sections are shown on Figure 8, and the geologic cross sections are shown on Figures 9 through 14. **(Revised January 30, 2015)**

ARCADIS also developed Geologic Cross Sections G-G' and H-H' to depict subsurface conditions on the eastern and southern sides of the SLA. These two cross sections were developed using information from the 37 test borings drilled by ARCADIS in February and March 2014 and previously developed phreatic surface information that was included in the December 2012 Report. The plan locations of the two ARCADIS geologic cross sections are shown on Figure 1 and the geologic cross sections are shown on Figure 2 of the ARCADIS summary at the end of Appendix A. (Revised January 30, 2015)

As shown on the geologic cross sections, the source materials were placed within three lagoons that were isolated from one another by internal dikes that were evidently constructed to contain the slurry. As shown on the geological cross sections, the source material ranges in thickness from about 20 to 40 feet. It is evident that source material was placed to the maximum elevations within each internal dike system and that placement of additional source material continued to the final elevations shown on the geologic cross sections. Generally, the bottom of Lagoon 1 is at an elevation in the range of 870 to 875 feet msl and the source material is in the range of 20 to 30 feet thick (Figures 9, 10, 13, and 14). The bottom elevation of Lagoon 2 is approximately 880 feet msl on its northern side but it deepens to an elevation of about 860 feet msl toward the south, and the thickness of the source material is in the range of 20 to nearly 40 feet (Figure 11 and **ARCADIS Report Figure 2 [Appendix A]**). The bottom of Lagoon 3 is at an elevation of approximately 860 feet msl on the northwestern part of the SLA but becomes shallower toward the south and east where the bottom elevation is at an approximate elevation of 880 feet msl (Figures 9, 10, 11, and 12). **(Revised January 30, 2015)**

Seven test pits (TP-1 through TP-7) were excavated on top of the SLA to determine the thickness of the topsoil and to observe the source material. Generally, the four test pits were excavated to depths of about four to five feet. As shown on the test pit logs, the topsoil zone was found to be about two to three inches thick and is immediately underlain by source material comprised of brown to gray clay and silt. Groundwater was observed to be flowing into the excavation in TP-1 at a depth of about 1.5 feet bgs, in TP-3 at a depth of about 2.5 feet bgs, and in TP 7 at a depth of about 1 foot bgs.

Visual inspection of the source materials indicates that they vary in color from red to gray, with the red color likely representing the rouge and the gray color likely representing lime and sodium bicarbonate that was placed in the former slurry lagoons. As indicated in Section 2.2.1, the source materials tested were classified as non-plastic silt (Unified Soil Classification System [USCS] symbol ML) having an in-place density ranging from medium dense to very dense, but is generally dense. Based on the relatively dense nature of the source material, it is likely that the lime component of the source material has weakly cemented the source material. This is an important characteristic of the source material because it indicates that fractures likely exist within the source material and that groundwater flow within the former slurry lagoons is likely in part controlled by secondary porosity of the fractures rather than being controlled by primary porosity within the source material.

Bedrock beneath the former slurry lagoons was encountered in 10 of the 13 test borings for the piezometers **as well as in all 37 test borings drilled by ARCADIS**. Bedrock was not encountered in the test borings for PZ-12, PZ-15, and PZ-17. Bedrock encountered in the test borings is comprised of interbedded weathered shale and sandstone, as determined from the split-barrel samples. **(Revised January 30, 2015)**

As shown on Figures 9 through 13, the existence and locations of the internal dikes that reportedly separated the three former slurry lagoons were confirmed in Test Borings PZ-8, PZ-11, PZ-13, and PZ-16. The internal dikes were evidently constructed to elevations in the range of 860 feet msl to 890 feet msl and were likely intended as temporary structures to separate the three areas of slurry placement. When the perimeter dikes were constructed to their current elevations, the slurry level was increased which resulted in overtopping of the internal dikes.

2.4.2 Glacial Soils

Geological information reviewed for the SLA indicated that glacial soil may be present in the northeastern corner of the SLA. Moreover, many of the glacial soils in western Pennsylvania are comprised of till that commonly contains groundwater. The test borings for Piezometers PZ-14 and PZ-15 were located with the intent of determining whether glacial soil is present in the northeastern corner of the SLA and, if so, to determine if groundwater is present in these soils and the extent to which groundwater may be recharging the groundwater table within the former slurry lagoons. **Test Borings SB-228, SB-229, and SB-230 drilled by ARCADIS also encountered the glacial soils, as shown on the test boring logs and on Figure 2 of the ARCADIS Report. (Revised January 30, 2015)**

The test boring for PZ-14 encountered glacial soil comprised of silty clay layers interbedded with sandy clay. The glacial till extends from ground surface to a depth of approximately 33 feet bgs. The test boring for PZ-15 also encountered glacial soil comprised of silty clay from ground surface to a depth of approximately 12 feet bgs. **Similarly, the three test borings drilled in the glacial soils by ARCADIS encountered clayey to sandy silt and layers of silty clay and weathered siltstone.** Groundwater levels measured in the piezometers installed in these two test borings indicate that groundwater is present in PZ-14 at a depth in the range of 7 to 8 feet, and in PZ-15, groundwater is present at a depth in the range of 1 to 2 feet bgs. The presence of groundwater in the glacial soils in immediate juxtaposition to Slurry Lagoon 3 combined with the relatively shallow depth to groundwater suggests that the glacial soil is a likely source of groundwater acting to recharge former Slurry Lagoon 3. **(Revised January 30, 2015)**

2.4.3 Slurry Lagoon Dikes

Southern Dike

The Southern Dike forms the southern boundary of the SLA and has an outside slope in the range of approximately 2 horizontal to 1 vertical (2H:1V) to 3H:1V. The top of the Southern Dike is at an elevation in the range of 895 to 905 feet msl, and the elevation of the South Bench at the toe of the slope is in the range of 860 to 880 feet msl. The elevation of the bottom of the slurry lagoon along the inside of the Southern Dike is in the range of 860 to 880 feet msl. The soils comprising this dike were evaluated to determine their type, thickness, and geotechnical engineering properties; the depth to and type of bedrock underlying the Southern Dike; and to determine if groundwater is present within the Southern Dike. Test Borings TB-1, TB-3, and TB-5 were drilled at the locations shown on Figure 7 to obtain this information. Upon completion of each test boring, a piezometer was installed to determine if a phreatic surface is present and, if so, the depth to groundwater. Geologic Cross Sections A-A’, B-B’, and C-C’ (Figures 9, 10, and 11) show the dike that forms the southern boundary of the site.

The test boring information indicates that the Southern Dike is comprised of a combination of source material and soil from which it is inferred that the dikes were likely constructed by using heavy construction equipment to simply form a containment structure. The soils were classified according to the USCS and consist of non-plastic silt (USCS symbol ML) to silty clay having low plasticity (USCS symbol CL). In-place densities of the material comprising the dike range from medium dense to very dense and cohesive soil is generally soft to medium stiff. The in-place density of the soil comprising the dike suggests that some compactive effort may have been used during the dike construction.

All three geotechnical test borings were carried to split-barrel sampler refusal on bedrock. Bedrock beneath the Southern Dike is comprised of weathered shale and sandstone.

Groundwater is present in all three piezometers that communicate with the Southern Dike. In TB-1, the depth to groundwater fluctuates between 13 and 27 feet bgs. In TB-3, the depth to groundwater fluctuates between 11 and 19 feet bgs, and in TB-5, the depth to groundwater fluctuates between 3 and 14 feet bgs. Two phreatic surfaces are shown in the Southern Dike on Geologic Cross Sections A-A’, B-B’, and C-C’ (Figures 9, 10, and 11): one representing the highest groundwater levels measured in the piezometers on May 20, 2011 and one representing the lowest groundwater levels measured in the piezometers on November 9, 2010. As will be described in Section 4.0, the phreatic surface identified in the piezometers was used in the stability analysis of the Southern Dike.

Western Slope

The Western Slope forms the western boundary of the SLA and has an outslope in the range of 2.5H:1V to 3H:1V. The top of the Western Slope is at an elevation in the range of 890 to 905 feet msl and the toe of the slope is at an elevation of about 780 feet msl. The elevation of the bottom of former Slurry Lagoons 1 and 3 on the western side of the SLA is in the range of 850 to nearly 880 feet msl. Therefore, the elevation of the bottom of the former slurry lagoons is 70 to 100 feet above the toe of the Western Slope. Although no test borings were drilled in the Western Slope due to very difficult access, the materials comprising the dike are believed to be essentially the same as those comprising the Southern Dike. Therefore, the geotechnical information developed for the stability analysis of the Southern Dike should also be representative of the material comprising the dike that forms the Western Slope. Geological conditions on the Western Slope are depicted on Geologic Cross Sections D-D’, E-E’, and F-F’ (Figures 12, 13, and 14).

Eastern Dike

The Eastern Dike forms the eastern boundary of the SLA and has an outslope in the range of 1.5H:1V to 2H:1V. The top of the Eastern Dike is 900 to 904 feet msl and the toe of the slope which forms the western bank of the Drainage Ditch has an elevation in the range of 860 feet msl at the southeastern corner of the SLA to 900 feet msl at the northwestern corner. The elevation of the bottom of the former slurry lagoons on the eastern side of the SLA is approximately 860 feet msl. The Drainage Ditch is a man-made feature that separates the SLA from the Solid Waste Area to the east. It flows southward at a gradient of approximately 188 feet per mile. Although no test borings were drilled in the Eastern Dike due to very difficult access, the materials comprising the dike are believed to be essentially the same as those comprising the Southern Dike. Therefore, the geotechnical information developed for the stability analysis of the Southern Dike should also be representative of the material comprising the Eastern Dike. Geological conditions on the Eastern Dike are depicted on Geologic Cross Sections D-D’, E-E’, and F-F’ (Figures 12, 13, and 14).

2.4.4 South Bench and Natural Slopes Below the South Bench

Test Boring TB-6 was drilled toward the western end of the South Bench and Test Pits TP-8, TP-11, TP-12, TP-13, TP-14, TP-15, and TP-16 were excavated on the South Bench (Figure 7). Test Pits TP-9 and TP-10 were excavated on the natural slope below the South Bench. The logs for TB-6 and the test pits are contained in Appendix A. As shown on the test boring and test pit logs, the depth to bedrock ranges from less than one foot (TP-11, TP-12, and TP-16) to more than nine feet in TB-6. Bedrock is commonly about two to three feet bgs and is comprised of weathered to relatively fresh sandstone. Sandstone outcrops are also present at a few locations on the South Bench. Water was observed to be flowing into the test pit excavations at a depth of two inches in TP-11, 1.4 feet in TP-14, one foot in TP-15, and eight inches in TP-16.

In areas of the South Bench in which the seeps emanate, areas of the South Bench that receive runoff from the seeps as they flow across the South Bench, and in some areas on the natural slope below the South Bench where runoff from the seeps occurs, a precipitate is present that appears to have the characteristics of travertine (soft, thinly laminated, and containing vugs). Much of the precipitate on the South Bench was either covered when the mulch beds were installed or when aggregate was placed to construct the access road when the IAS was installed and is no longer exposed at ground surface. Some isolated areas of precipitate remain on the South Bench and on the natural slope below the South Bench, particularly in the area immediately downslope of Outfall 001, which is the outfall from which water treated in the IAS is discharged. Since discharge of treated water at Outfall 001 began, the slope below the outfall pipe has started to naturally revegetate itself with volunteer grasses. As described in Section 2.2.7, samples of the talus were collected and analyzed to evaluate the contribution that this material may be having on higher pH water discharging from the South Bench and the natural slope.

Numerous sandstone boulders are present on top of the natural slope below the South Bench suggesting a very shallow depth to bedrock. Excavation of Test Pits TP-9 and TP-10 confirmed the shallow depth to bedrock when sandstone was encountered at a depth of less than one foot bgs in each test pit.

2.4.5 Groundwater (Leachate) Conditions Within the Former Slurry Lagoons (2009-2011)

Groundwater levels were measured in the piezometers during the period June 25, 2009 through June 20, 2011 and the results are shown on Table 3. Groundwater is present within the former slurry lagoons as shown on the geologic cross sections in Figures 9 through 14. Two phreatic surfaces are shown on the geologic cross sections: one representing the lowest ~~groundwater table condition~~ **phreatic surface** based on groundwater levels measured on November 9, 2010 and one representing the highest seasonal ~~groundwater table condition~~ **phreatic surface** based on groundwater levels measured on May 20, 2011. As shown on the geologic cross sections,

~~groundwater~~ **phreatic** levels fluctuated by as much as 14 feet over the period of measurements. The ~~groundwater~~ levels measured in the piezometers indicate that the phreatic surface is persistently above the elevation of the South Bench, the bottom of the Drainage Ditch, and the base of the slurry lagoon adjacent to the Western Slope. **(Revised January 30, 2015)**

Figures 15 and 16 are groundwater contour maps that were prepared based on the lowest and highest groundwater table configurations. Groundwater flow lines were also added to the groundwater contour maps to create two dimensional groundwater flow nets that were used to establish flow paths and groundwater drainage areas for both the low and high seasonal groundwater conditions. As shown by the color shaded areas on Figure 15, when the lowest seasonal groundwater condition occurred, three groundwater drainage areas were present in the SLA. Groundwater Drainage Area 1 covers an area of approximately 39 acres, and groundwater within this area flows westward toward the Western Slope. Groundwater Drainage Area 2 occupies an area of approximately 33 acres, and groundwater within this area flows southward toward the South Bench. Groundwater Drainage Area 3 occupies an area of approximately 18 acres, and groundwater within this area flows eastward toward the Drainage Ditch.

As shown by the color shaded areas on Figure 16, when the highest seasonal groundwater condition occurred, the same three groundwater drainage areas were present in the SLA. Groundwater Drainage Area 1 covers an area of approximately 44 acres, and groundwater within this area flows westward toward the Western Slope. Groundwater Drainage Area 2 occupies an area of approximately 34 acres, and groundwater within this area flows southward toward the South Bench. Groundwater Drainage Area 3 occupies an area of approximately 12 acres, and groundwater within this area flows eastward toward the Drainage Ditch.

Construction of the groundwater contour and groundwater drainage area maps for the lowest and highest seasonal groundwater configurations demonstrates that three persistent groundwater drainage areas exist within the SLA. Figures 15 and 16 also demonstrate that groundwater flow within the former slurry lagoons is essentially radial with groundwater flowing eastward toward the Drainage Ditch, southward toward the South Bench, and westward toward the Western Slope. The groundwater drainage maps are helpful in assessing the presence of the seeps on the South Bench, Western Slope, and in the Drainage Ditch. These seeps likely represent discharge locations at which fracture-controlled ~~groundwater~~ **leachate** flows within the former slurry lagoons and discharges at ground surface. Definition of the three groundwater drainage areas also allows for evaluating remedial alternatives from the perspective of engineering modifications to reduce infiltration of storm water and hence reduce the flows at the various seep locations. **(Revised January 30, 2015)**

3.0 Summary and Evaluation of Analytical Results

The following data gaps were identified as they relate to the materials and various water sources at the SLA:

- Geotechnical properties of the materials comprising the Southern Dike
- Impacts from the facility on the Allegheny River and Glade Run
- Chemistry of the source and secondary materials
- Chemistry of water ponded on top of the SLA and chemistry of storm water runoff from the site
- Lime and fertilizer requirements for the soils underlying areas devoid of vegetation on the upper surface of the SLA
- **Chemistry of leachate within the SLA**
- **Distribution of pH impacts in the eastern Drainage Ditch**
- **Chemistry of bedrock groundwater in the eastern portion of the South Bench**
- **Bench-scale treatability testing**

Analytical results for each of these data gaps are described in this section. The geotechnical testing was performed in accordance with methodologies established by the ASTM while the various chemical analyses were performed using either "Standard Methods for the Examination of Water and Wastewater," 18th Edition or 20th Edition or "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," Third Edition, November 1986 and its updates. The agronomic soil samples were tested in the Agricultural Analytical Services Laboratory at The Pennsylvania State University using the test methods developed by the laboratory. **(Revised January 30, 2015)**

3.1 Soil Samples for Geotechnical Analysis (2009-2011)

The Shelby tube samples collected in Test Borings TB-1, TB-3, and TB-5 were analyzed for the following geotechnical properties using established ASTM methods:

- Grain size distribution, including sieve, hydrometer, and Atterberg Limits (ASTM D 422-63)
- Permeability (ASTM D 5084-03)
- Consolidated undrained triaxial shear strength with pore water readings (ASTM D 4767-95)

The analytical results are summarized on Table 5 and the laboratory reports are contained in Appendix B.

The soils underlying the Southern Dike are comprised of natural soil and source material that was placed to form the dike. The USCS classification of these soils are silt and sandy silt (ML) and sandy silty clay (CL-ML). Two samples were analyzed for shear strength using the consolidated undrained triaxial shear strength test and they were determined to have high shear strength with friction angles (Φ) of 35.38 and 37.72 degrees and cohesion values of 3.82 pounds per square inch (psi) and of 1.18 psi. The permeability of the soil, based on the results of one test on a sample from TB-5, is 2.7×10^{-8} centimeters per second, indicating that some soils comprising the Southern Dike have a very low permeability. The sample that was tested contained no discernible fractures, which supports the conclusion regarding fracture flow discussed in Section 2.4.5. The results of the shear strength testing were used for performing the slope stability analysis discussed in Section 4.0.

3.2 Evaluation of the Allegheny River and Glade Run (2009-2011)

As described in Section 2.2.4, a water quality investigation was performed on a “snapshot” basis to determine flow conditions and water chemistry within the Allegheny River and Glade Run, the two streams that receive runoff from the SLA. The purpose of the investigation was to determine if there have been adverse impacts to these streams from the site. Samples of water were collected along five transects in the Allegheny River at the locations shown on Figure 6 (AR-1 through AR-5) and in Glade Run upstream of the SLA (GR-1), adjacent to the western side of the SLA (GR-2), and at the confluence of the Allegheny River (GR-3). Table 6 contains a summary of the analytical results and the laboratory reports are contained in Appendix C.

3.2.1 Allegheny River Samples (2009-2011)

Evaluation of the analytical results for the samples collected in the Allegheny River indicates that there were no discernable differences between the analytical results for the upstream samples, samples collected adjacent to the SLA, and the downstream samples. Moreover, as shown on Table 6, the concentrations of some parameters are slightly higher in the upstream samples than in the samples collected downstream. These parameters include TDS at a concentration of 126 milligrams per liter (mg/L) in upstream sample AR-1-10 as opposed to an average TDS value of 114 mg/L in the downstream samples. The range of TDS concentrations was 106 mg/L to 126 mg/L. Aluminum was detected in upstream sample AR-1-10 at a concentration of 753 micrograms per liter (µg/L) as opposed to an average concentration of 211 µg/L in the downstream samples. The range of aluminum concentrations was 121 µg/L to 753 µg/L, but nine of the 15 samples analyzed had estimated concentrations because the results were less than the reporting limit. Iron was detected in upstream sample AR-1-10 at a concentration of 1,180 µg/L as opposed to an average concentration of 350 µg/L in the downstream samples. The range of iron concentrations was 100 µg/L to 1,180 µg/L. The upstream sample in which the higher concentrations were detected (AR-1-10) was collected 10 feet from the bank of the river.

3.2.2 Glade Run Samples (2009-2011)

As shown on Table 6, analytical results for the samples collected from Glade Run indicate a generally decreasing trend in the concentrations or values from upstream to downstream. These concentrations and values are overall within the ranges typically seen in stream samples in western Pennsylvania. Moreover, Glade Run is believed to be impacted by acid mine drainage (AMD) upstream of the SLA. The ranges of concentrations of specific conductance, TDS, iron, and aluminum, which are constituents indicative of AMD, are as follows:

- Specific conductance – 870 µmhos/centimeter upstream and 249 µmhos/centimeter downstream
- TDS – 568 mg/L upstream and 117 mg/L downstream
- Iron – 4,690 µg/L upstream and 853 µg/L downstream
- Aluminum – 1,040 µg/L upstream and 524 µg/L downstream

The TDS, aluminum, and iron in the upstream sample are representative of water chemistry impacted by AMD rather than water discharging from the seeps at the SLA.

3.3 Chemistry of Source and Secondary Materials (2009-2011)

As described in Section 2.2.5, samples of the source material were analyzed to characterize the chemistry of the material. A total of 24 samples (three samples were analyzed from each of eight selected piezometer test borings) were analyzed to obtain a profile of the chemical characteristics of the source material with depth. The source materials have been analyzed for aluminum, arsenic, chromium, iron, sodium, lead, pH, and total alkalinity. The locations of the piezometer test borings from which the samples were collected are shown on Figure 6, and Table 7 summarizes the analytical results. The laboratory reports are contained in Appendix D.

The analytical results for the source samples generally reflect the nature of the materials that were deposited in the former slurry lagoons. For example, the presence of iron and sodium reflect the chemistry of the rouge and sodium bicarbonate that were used in the glass manufacturing process. Moreover, the pH values and alkalinity are representative of the chemistry of the lime and soda ash that were used in the glass manufacturing process.

A total of three talus samples were collected on the slope below the South Bench to evaluate this material as a potential secondary source that could adversely impact the quality of water that comes into contact with these materials. The talus is essentially comprised of a mixture of soil and precipitate that formed downslope of some of the seeps. The locations of the talus samples, designated Talus-1, Talus-2, and Talus-3, are shown on Figure 6. The samples were analyzed for aluminum, arsenic, chromium, iron, sodium, lead, antimony, pH, and total alkalinity. The analytical results are shown on Table 9 and the laboratory reports are contained in Appendix F. As shown on Table 9, arsenic, chromium, and antimony concentrations were reported to be slightly above or less than the reporting limit. Aluminum concentrations in the talus samples are typically higher than the aluminum concentrations in the source material, reflecting the soil component of the talus with clay being the primary source of the aluminum. Iron concentrations are significantly lower than the iron concentrations in the source material, and lead and sodium concentrations are in the same range as the lead and sodium concentrations in the source material. Evaluation of the analytical results for the talus samples suggests that the talus is not a significant secondary leaching source of metals because concentrations of the analyzed constituents are generally lower than the concentrations of the same constituents in the source material.

3.4 Ponded Water and Storm Water Runoff Samples (2009-2011)

As described in Section 2.2.6, four samples of water were collected from areas of standing water (ponded water) on top of the SLA and two samples of storm water runoff were collected for analysis. The purpose of analyzing ponded water and runoff water samples was to evaluate whether these waters have been impacted by the source materials in the lagoons. The locations at which these samples have been collected are shown on Figure 6. The two storm water runoff samples are designated Runoff-1 and Runoff-2, and the locations at which they were collected are shown on Figure 6. The results of the ponded water samples are shown in Table 8 and the laboratory reports are contained in Appendix E.

Analytical results for the ponded water and the Runoff-1 samples show no impact from the SLA based on the results of the general chemistry parameters pH, total alkalinity, and TDS. The pH of the ponded water samples and Runoff-1 sample is in the range of 7.0 to 7.7 standard units, which is three to four standard pH units lower than the pH of the water emanating from the seeps. Total alkalinity and TDS concentrations are significantly lower than the concentrations of these constituents in the seeps. Therefore, the areas of ponded water on top of the SLA and the storm water discharging from the western side of the SLA show no significant impact from the source materials. The metals concentrations in the ponded water and Runoff-1 samples generally reflect the chemistry of the suspended solids fraction in the samples. For example, aluminum concentrations are higher than aluminum concentrations in the source material as would be expected, thus reflecting the presence of clay suspended in the water. Iron concentrations are lower than iron concentrations in the source material representing the iron present in the suspended material rather than source material.

The results for the Runoff-2 sample generally differ from the results of the weekly seep samples that are collected and analyzed in accordance with the AO. The pH of the Runoff-2 sample is approximately 1 to 1.5 standard units lower than in the typical analytical results for the seep weekly samples. The metals concentrations generally are also lower in the Runoff-2 sample than in the weekly seep samples. This difference in chemistry likely reflects the dilution effect of relatively unimpacted storm water runoff mixing with the water that discharges into the Drainage Ditch from the SLA.

Based on the evaluation of the analytical results for the ponded water and runoff samples, it is concluded the source materials in the SLA are having no adverse impacts on the area of ponded water and on runoff from the SLA.

3.5 Agronomic Analysis (2009-2011)

Soil samples from five of the test plots (RTP-1, RTP-2, RTP-3, RTP-4, and RTP-6), two test pits (TP-2-B and TP-4-B), and one surface sample (STP-2-B) were collected and shipped to the Pennsylvania State University Agricultural Analytical Services Laboratory for analysis of fertilizer requirements. The results of the soil analyses are shown in Table 10, and the laboratory reports are contained in Appendix G. The measured values for pH, phosphorous, and potassium are shown on Table 10, along with the recommended amendments that would be added during the revegetation process. For any areas of the SLA that require revegetation, the soils should be amended with the recommended rates of phosphorous and potassium, with one addition. Based on the evaluation of the revegetation test plots summarized in Section 2.2.8, the addition of elemental sulfur to the soil improved the germination and growth of the alkali grass (Pucinella distans).

The tensiometer readings indicated that capillary rise of water within the source materials did occur. Results of the test plot experiment indicated that one of the seven species of grass seed, Pucinella distans “fults” (alkali grass), germinated and thrived. Moreover, the alkali grass achieved a more vigorous growth in the soil amended with sulfur than in the soil that was not amended with sulfur.

3.6 Evaluation of Weekly Seep and Stream Monitoring (2009-2014)

Weekly monitoring of the seeps and receiving streams is required under Paragraph A of the Performance Obligations section of the AO. The weekly monitoring is to include the following parameters: flow, pH, TSS, O&G, aluminum, arsenic, chromium, iron, lead, and antimony. Analytical results for the weekly monitoring are summarized on the tables in Appendix H. Provided below is an evaluation of each of these required monitoring parameters.

Flow from the seeps and flow in the Allegheny River and Glade Run are measured weekly. With respect to the seeps, the maximum measured flow rate was approximately 580 gpm on May 8, 2012; the minimum flow rate was ~~1.2~~ **zero** gpm on January **28, 2014** ~~5, 2010~~; and the mean flow rate ~~is~~ **remained at** approximately 29 gpm after adjusting the data to exclude obvious weather-related flows. For example, the maximum flow rate for the seeps measured on May 8, 2012 was likely a result of a rainfall event that day during which 1.5 inches of rainfall occurred and runoff mixed with seep discharges at some seep locations. Likewise, the minimum flow rate of ~~1.2~~ **0** gpm on January **28, 2014** ~~5, 2012~~ occurred after ~~nine~~ **seven** consecutive days when the temperature ~~only rose~~ **did not rise** above freezing ~~on one day~~ and there were ~~two~~ **five** nights during that period of time when the nighttime temperature was ~~5 degrees~~ **in the range of 0 to minus 13 degrees** Fahrenheit (°F) ~~and 6°F~~. The seeps were largely frozen on January **28, 2014** ~~5, 2012~~ and flow rates could not be measured. The average discharge from the drainage channel along the Pittsburgh and Shawmut Railroad tracks was determined through flow measurements in the culverts into which the drainage channel discharges to be approximately 8 gpm as measured during the period April 27, 2012 through October 2012. Adding this flow rate into the above-referenced flow rate yields an average flow rate discharging from the SLA of 37 gpm. **(Revised January 30, 2015)**

Flow in the Allegheny River is both seasonal and weather dependent with the highest flows generally occurring during the winter and early spring and following heavy and prolonged rainfall events. The lowest flows typically occur during the summer and early fall. From April 6, 2009 through **December 9, 2014** ~~July 31, 2012~~, the maximum annual flow rates were 12.8 million gpm on April 6, 2009; 22.7 million gpm on February 16, 2010; 32.2 million gpm on March 15, 2011; ~~and~~ 19.6 million gpm on January 31, 2012**; 19.6 million gpm on July 2, 2013; and 19.8 million gpm on January 14, 2014**. Minimum annual flow rates during the same period were 1.91 million gpm on September 22, 2009; 1.71 million gpm on September 17, 2010; 1.04 million gpm on August 2, 2011; ~~and~~ 1.31 million gpm on July 24, 2012 **and August 21, 2012; 1.39 million gpm on August 27, 2013; and 2.57 million gpm on October 7, 2014**. Considering that the average flow rate discharging from the seeps is 37 gpm, the contribution of flow from the seeps is insignificant compared to the flow in the Allegheny River, even during the lowest periods of river flow. **(Revised January 30, 2015)**

Flow in Glade Run is also both seasonal and weather dependent with the highest flows generally occurring during the winter and early spring months and following periods of heavy and prolonged rainfall events. During the period April 6, 2009 through **December 9, 2014** ~~July 31, 2012~~, the maximum annual flow rates were 33,186 gpm on May 4, 2009; 100,668 gpm on January 26, 2010; 31,559 gpm on August 8, 2011; and **67,639** gpm on **May 8, 2012** ~~January 17, 2012~~**; 57,925 gpm on December 30, 2013; and 58,249 gpm on January 14, 2014**. During several of the monitoring events in 2011 and early 2012, Glade Run was flooding and flow measurements could not be obtained. Minimum annual flow rates measured during the monitoring period were 1,338 gpm on June 16, 2009; 1,699 gpm on September 14, 2010;

1,761 gpm on July 19, 2011; and **194 gpm on July 3, 2012 followed by** 1,308 gpm on July 10, 17, and 24, 2012**; 2,263 gpm on June 25, 2013; and 9,894 on September 30, 2014**. The average seepage from the Western Slope is 10.6 gpm. **(Revised January 30, 2015)**

The chemistry of the seeps is evaluated in detail in Section 6.0 of this report to determine impacts from the SLA on the Allegheny River. As will be described in Section 6.0, the concentrations of the metals contained in the water emanating from the seeps are very minor compared to the assimilative capacity of the Allegheny River, from which it is concluded that the impacts to water quality of the Allegheny River from seeps is insignificant.

3.7 Chemistry of the Leachate within the Former Slurry Lagoons (2014)

As indicated in Section 2.2.11 of this Revised Report, an important component of evaluating the viability of installing internal interceptor trenches was determining the chemistry of the leachate that would be collected in this system. (Revised January 30, 2015)

Leachate samples were collected from several of the existing piezometers in May 2014. The sampling was completed to characterize the leachate and evaluate the distribution of the metals and silica in SLA leachate that would be intercepted by the proposed internal collection system. As described in Section 2.2.12, leachate samples were collected from 10 existing piezometers (PZ-1, PZ-2, PZ-3, PZ-6S, PZ-7, PZ-8, PZ-9, PZ-15, PZ-16, and PZ-17) in the southern and eastern portions of the SLA. Leachate samples were submitted to TestAmerica for total and dissolved metals and various wet chemistry/physical parameters. Sampling procedures that were implemented to collect the samples and the analytical results and laboratory reports are contained in Appendix S. (Revised January 30, 2015)

The results obtained from this sampling event were used to select individual leachate samples to create composite leachate samples. As shown in Appendix S, comparing the May 2014 individual leachate sample concentrations from within the SLA to results of seep samples used in prior treatability studies and average seep water sample concentrations from 2012 monitoring, it is evident that the chemical characteristics of the leachate (dissolved metals and silica) differed from those of the seep water previously tested. In general, the leachate water proved to have lower metals concentrations but higher silica concentrations as compared to the seep water metals and silica concentrations. (Revised January 30, 2015)

3.8 Drainage Ditch pH Impacts (2014)

To support remedial alternative evaluations for pH-impacted water in the Drainage Ditch, surface water distribution of pH was delineated. Surface water and nearby SLA

piezometers were field tested for pH levels in March, April, and July 2014 as depicted on Figure 3 in Appendix Q. (Revised January 23, 2014)

pH was measured in surface water from both banks and the corresponding central portion of the water flow in the Drainage Ditch at approximate 50-foot intervals from the weir bypass north until water was not present in the bottom of the Drainage Ditch. Grab surface water samples were collected and measured with duplicate pH meters, and average pH readings in standard units are shown on Figure 3 in Appendix Q. pH measurements were also collected from Piezometers PZ-14 through PZ-17 along the eastern boundary at the same time as these monitoring events to compare pH from groundwater within the SLA to adjacent surface water readings. (Revised January 30, 2015)

As shown on Figure 3 in Appendix Q, the following observations were made with regard to the pH of the water in the Drainage Ditch:

- **pH levels in the southern portion of the Drainage Ditch were measured up to 11.8 standard units, similar to levels monitored from named seep location Seep 105 in the ditch**
- **pH in groundwater from piezometers adjacent to the Drainage Ditch were similar to corresponding pH levels measured in the water in the Drainage Ditch.**
- **pH levels are generally below 10.0 standard units approximately 500 feet north of the weir bypass and drop below 9.0 standard units in Drainage Ditch water north of PZ-15**

(Revised January 30, 2015)

The conceptual site hydrologic model for shallow groundwater described in Section 5.1.1 of the December 2012 Report concluded that there is a component of groundwater discharge from the eastern side of the SLA to the Drainage Ditch, and the results of the pH study confirm this conclusion. The results of the pH study also indicate that the discharge from Seep 105 appears to mix quickly with flow in the Drainage Ditch. (Revised January 30, 2015)

3.9 Chemistry of Bedrock Groundwater in Eastern South Bench (2014)

The two bedrock wells installed in March 2014 (MW-20 and MW-21) along the eastern portion of the South Bench to further assess the conceptual site hydrologic model of seep versus groundwater flow above the Pittsburgh and Shawmut railroad tracks were field tested for pH on multiple occasions. This testing started immediately after the wells were installed in March 2014 and continued until July 2014. The results of this pH analysis are further summarized in Section 5.1.2 of this Revised Report. Sampling of MW-20 and

MW-21 was also attempted twice in March and April 2014. The deeper screened bedrock well, MW-20, was either dry or had insufficient water to sample after purging on the first four monitoring attempts. MW-20 had sufficient water to collect groundwater samples prior to purging as part of the July 23, 2014 sampling event. (Revised January 30, 2015)

Initial readings immediately following installation of Monitoring Wells MW-20 and MW-21 showed pH above 9.0 standard units in both wells. However, it was believed that seep water from the relatively shallow overburden above the bedrock zones being tested may have entered the wells during installation. Following subsequent testing, when the wells were purged dry and further tested for pH as well as other field water quality parameters, pH levels decreased to more neutral values, with the final measurements of 8.14 and 7.17 standard units in Wells MW-20 and MW-21, respectively. (Revised January 30, 2015)

On April 1 and July 23, 2014, samples were collected from MW-20 and MW-21 (MW-20 was dry on April 1) for laboratory analysis of total and dissolved target metals, silica, pH, alkalinity, and TDS. Analytical results for these sampling events are summarized in the table in Appendix U and the laboratory reports are also included in this appendix. Compared to the concentrations of the analyzed parameters in average seep water and previous treatability testing baseline samples, metals and silica concentrations were generally much lower in groundwater in MW-20 and MW-21 with a few exceptions (total aluminum and iron were higher and arsenic was similar to prior seep water concentrations); however, given that the monitoring wells are screened in shale and sandy shale, higher aluminum, iron, and arsenic concentrations are not unexpected due to the presence of clay minerals and heavy metals that are commonly associated with shale. More importantly, the average seep pH values were generally above 11.0 standard units while the pH of groundwater in MW-20 and MW-21 was close to the neutral range. (Revised January 30, 2015)

4.0 Geotechnical Evaluation

4.1 Methodology and Input Information

One data gap identified in the Treatment Plan was to analyze the stability of the dikes that were constructed to form the former slurry lagoons so that the long-term stability of these structures could be evaluated. Also, a topographic feature on the Western Slope that appears to be an incipient slump based on the configuration of the topographic contour lines was to be evaluated as part of the Treatment Plan. This section of the Report provides a geotechnical evaluation of the dikes that form the eastern, southern, and western boundaries of the SLA.

The morphologies of the dikes are described in Section 2.4.3 of this Report, and the slopes of the downstream face of each dike were used in the slope stability analysis. The slope stability analyses were performed under both static (no earthquake) and seismic (earthquake) conditions to determine the minimum factors of safety for the dikes on the eastern, southern, and western sides of the SLA. For the seismic analyses, an earthquake factor of 0.055 was used based on the 50-year (two percent) earthquake probability as shown on geohazards maps for the United States developed by the U.S. Geological Survey (USGS). The 50-year earthquake probability is generally accepted by regulators for use in seismic slope stability analysis. For the dikes along the eastern and southern sides of the SLA, the stabilities of the critical embankment sections were analyzed. For the stability analysis of the Western Slope, the section analyzed is within the topographic feature believed to be an incipient slump. The locations of the three embankment sections that were analyzed are shown on Figure 7. Each stability analysis incorporated a phreatic surface based on the average groundwater level within the former slurry lagoons. The slope stability analyses were performed using geotechnical information obtained from the tests performed on samples obtained from Test Borings TB-1, TB-3, and TB-5. The results of the geotechnical testing are summarized on Table 5.

The slope stability analyses were performed utilizing the STEDwin 2.84/GSTABL7 slope stability computer program developed by Annapolis Engineering Software/Gregory Geotechnical Software. This version of the program was released in November 2009. Using the random search Modified Bishop Method, the minimum factor of safety was calculated for the two above-listed cases. The Modified Bishop Method is a circular failure surface analysis. A total of 100 trial failure surfaces were generated for each analysis, and the corresponding factors of safety were calculated. After all the factors of safety were calculated, the ten lowest factors of safety were displayed and plotted on the sections shown in the computer-generated output. A copy of the computer-generated output is contained in Appendix I.

The following soil and bedrock properties were used for the slope stability analysis:

Soil Unit	Total Unit Weight (pcf)[(1)]	Saturated Unit Weight (pcf)[(1)]	Cohesion (psf)[(2)]	Friction Angle (degrees)
Dike Soil	90.0	106.0	100 [(3)]	35.0[(4)]
Source Material[(5)]	75.0	80.0	100	0
Bedrock[(5)]	135.0	135.0	1,000.0	0

(1) pcf = pounds per cubic foot.

(2) psf = pounds per square foot.

(3) The 100 pounds per square foot value Is a conservative value based on rounding of the lowest triaxial shear test result.

(4) The 35 degree friction angle is a conservative value based on rounding down the lowest triaxial shear test result.

(5) Assigned values based on professional judgment.

4.2 Stability Analysis Results

The table below summarizes the results of the slope stability analyses for the eastern, southern, and western slopes of the former slurry lagoons.

Stability Analysis Results – Minimum Factors of Safety

Slurry Lagoon Dike	Static Condition	Seismic Condition
Eastern Slope	1.90	1.66
Southern Slope	1.88	1.61
Western Slope	1.47	1.28

Eastern Dike

The eastern dike faces toward the east and extends from the top of the slurry lagoon down to the Drainage Ditch. The dike that was constructed to form Lagoons 1, 2, and 3 on the eastern side of the SLA has a maximum height of approximately 40 feet and a slope in the range of approximately 1.5H:1V to 2H:1V. The minimum factor of safety of the slope was determined to be 1.90 for the static case and 1.66 under the seismic case.

Southern Slope

The southern dike faces southward and extends from the top of the slurry lagoon down to the South Bench. The dike that was constructed to form Lagoons 1 and 2 on the southern side of the SLA has a maximum height of approximately 35 feet and a slope of approximately 2H:1V to 3H:1V. The minimum factor of safety of the slope was determined to be 1.88 under the static case and 1.66 under the seismic case.

Western Slope

The Western Slope forms the western boundary of the SLA. The dike that was constructed to form Lagoon No.3 in the western part of the SLA is approximately 30 feet high and is founded on bedrock. The dike itself has a height of approximately 30 feet and a slope in the range of 2.5H:1V to 3H:1V. The natural slope below the dike is approximately 70 feet high and has the same slope as the dike, 2.5H:1V to 3:H:1V. It appears that the dike was constructed to form one continuous slope from the top of the lagoon to the toe of the slope. The minimum factor of safety of the dike was determined to be 1.47 for the static case and 1.28 for the seismic case.

Based on a visual field inspection of the Western Slope, the topographic features that indicated the potential for the presence of an incipient slump were identified as erosion channels that have developed on the slope. Two existing swales that are present on top of the dike mark the upstream ends of the erosion channels (see Figure 2). Therefore, what was initially identified as a potential incipient slump is in reality an erosional feature. No evidence of slope movement such as bulging of the slope or subsidence of the top of the dike were noted during the visual inspection.

4.3 Stability Evaluation

Good engineering practice generally dictates that earthen embankments be designed to have a factor of safety of 1.5 under static conditions and 1.1 under seismic (earthquake) conditions. The stability analyses performed for the eastern and southern dikes indicate that these standards are met for both the static and seismic cases. The factor of safety for the western dike is slightly below 1.5 for the static case with a factor of safety of 1.47, but the slope is not considered unstable and exceeds the typical minimum safety factor for the seismic case.

4.4 Additional Slope Stability Evaluations

Comments Nos. 13 through 18 of the Department's May 13, 2014 Comment Letter addressed the results of the slope stability analysis described in Sections 4.1 through 4.3 of the December 2012 Report. Responses to the Department's comments were contained in the June 25, 2014 Response Letter and they were further discussed during the July 16, 2014 and October 27, 2014 meetings between PPG and the Department and follow-up November 7 and 10, 2014 emails between PPG and the Department (Appendix Z). Described below are additional slope stability evaluations that will be performed to evaluate the stability of the eastern, southern, and western slopes of the SLA. (Revised January 30, 2015)

The stability of the earthen embankments along the eastern, southern, and western sides of the SLA will be further evaluated to determine their long-term steady-state condition. As agreed upon with the Department, three new geotechnical test borings will be drilled at the locations shown on revised Figure 7. Proposed Test Boring TB-7 will be drilled on top of the dike above the South Bench at the location shown on revised Figure 7. The location of the test boring on top of the dike adjacent to the South Bench will be in an approximate

alignment with existing Piezometers PZ-18 and PZ-19 and the cluster of seeps on the South Bench. Drilling Test Boring TB-7 in alignment with PZ-18 and PZ-19 and the seeps will allow for the development of a detailed geological cross section through the former slurry lagoon and extending to the South Bench, and the slope stability analysis of the dike will utilize this cross section of the dike. (Revised January 30, 2015)

TB-7 will be drilled using a geotechnical drill rig. The test boring will be advanced from ground surface to final depth on top of bedrock by collecting continuous split-barrel samples and advancing the drill string between sampling intervals using hollow-stem augers. During the drilling, a scientist under the direction of a geologist having a license in the Commonwealth of Pennsylvania will log the test borings, describing the materials encountered, the density or consistency based on the SPT, the moisture content, and any other pertinent properties observed in the split-barrel samples. The depth at which any groundwater inflow is observed while the test boring is being drilled will be recorded. (Revised January 30, 2015)

Following completion of Test Boring TB-7, the split-barrel samples will be evaluated for vertical uniformity of the material encountered and two intervals representative of the materials comprising the dike material will be selected for collecting Shelby tube samples for geotechnical laboratory analysis. These two Shelby tubes samples will be collected by augering a test boring within 2 to 3 feet of TB-7 and pushing the Shelby tubes through the desired sampling intervals. An attempt will be made to obtain a recovery of at least 90 percent in the Shelby tubes to provide as much material as possible for the geotechnical laboratory analysis. (Revised January 30, 2015)

At the completion of drilling, the location and elevation of the test boring will be obtained using a hand-held global positioning system unit and zero-hour depth to groundwater measurement will be collected. Depth to groundwater measurements will also be made in PZ-3, PZ-18, and PZ-19 immediately after the water level is measured in the TB-7 borehole in order to obtain a profile of the phreatic surface within the former slurry lagoon along the proposed geologic cross section line. After obtaining the zero-hour groundwater measurement, a slope indicator will be installed in the TB-7 borehole from ground surface to the top of bedrock in accordance with manufacturer's recommendations. (Revised January 30, 2015)

Proposed Test Boring TB-8 will be drilled on top of the eastern perimeter dike at the approximate location shown on revised Figure 7. It will be drilled along the Cross Section H-H' so that the test boring is aligned with Seep 105. The test boring will be drilled using the same methodology as described above for TB-7. The soil samples retrieved during the drilling of TB-8 will be visually evaluated and compared to the soil samples

retrieved in TB-7. Assuming that the soil samples from the two test borings are similar in soil type and consistency or density, no additional Shelby tubes samples will be obtained and the laboratory results for the samples from TB-7 will be utilized to define the soil properties for the subsequent slope stability analysis of the eastern perimeter dike. In the unlikely event that there is a significant difference in soil types, laboratory testing for grain size distribution and shear strength (consolidated drained direct shear test) will be performed on an undisturbed sample of soil collected in TB-8. After obtaining the zero-hour groundwater measurement, a slope indicator will be installed in the TB-8 borehole from ground surface to the top of bedrock in accordance with manufacturer's recommendations. (Revised January 30, 2015)

Proposed Test Boring TB-9 will be drilled on top of the western perimeter dike at the approximate location shown on revised Figure 7. TB-9 will not be drilled directly along the Cross Section I-I' because the existing bed of riprap that was placed in the 1990s to address the erosion on the Western Slope would be an obstruction to drilling. However, the test boring location will be aligned with Seep 106 which will result in delineating the subsurface soil and groundwater conditions in the perimeter dike. The test boring will be drilled using the same methodology as described above for TB-7. The soil samples retrieved during the drilling of TB-9 will be visually evaluated and compared to the soil samples retrieved in TB-7. Assuming that the soil samples from the two test borings are similar in soil type, consistency, or density, no additional Shelby tubes samples will be obtained and the laboratory results for the samples from TB-7 will be utilized as the soil properties for the subsequent slope stability analysis of the western perimeter dike. In the unlikely event that there is a significant difference in soil types, laboratory testing for grain size distribution and shear strength (consolidated drained direct shear test) will be performed on an undisturbed sample of soil collected in TB-9. After obtaining the zero-hour groundwater measurements, a slope indicator will be installed in the TB-9 borehole from ground surface to the top of bedrock in accordance with manufacturer's recommendations. (Revised January 30, 2015)

Geotechnical Laboratory Analyses

The Shelby tube samples from TB-7 will be transported to Geotechnics, Inc. of East Pittsburgh, Pennsylvania, for geotechnical laboratory analyses. The following testing program will be performed on the samples of dike material, contingent on sample recovery being sufficient and any updates on observations from the drilling activity:

- **Consolidated drained direct shear test using ASTM International (ASTM) Method D 3080**

- **Permeability – ASTM Method D 5084 (only performed if sufficient sample recovery permits)**
- **Natural moisture content – ASTM Method D 2216**
- **Grain size distribution – sieve and hydrometer analysis – ASTM Method D 422**
- **Atterberg limits – ASTM Method D 4318**

Normal loads that will be used for the direct shear test will be selected to replicate the vertical stress within the dike adjacent to the South Bench. Unit weight of the soil is included in the direct shear test, thus precluding the need for a separate test.

Upon receiving the analytical results, a slope stability analysis will be performed to determine the factor of safety of the dikes adjacent to the Drainage Ditch on the eastern side of the SLA, the South Bench, and the Western Slope. (Revised January 30, 2015)

Slope Stability Analyses

Slope stability analyses will be performed utilizing the STEDwin 2.84/GSTABL7 slope stability computer program developed by Annapolis Engineering Software/Gregory Geotechnical Software. This version of the program was released in November 2009. This analytical program uses the random search Modified Bishop Method to determine the minimum factor of safety. The dikes on the eastern, southern, and western sides of the SLA will be analyzed under both static and dynamic (earthquake) conditions. The stability analyses that will be performed for the perimeter dikes above the Drainage Ditch (eastern slope) and the South Bench will incorporate the proposed interceptor trench when the slope stability models are constructed. Geotechnical properties from the above-described laboratory analytical program as well as geotechnical properties of the soils analyzed as part of the Treatment Plan implementation and described in the December 2012 Report will be utilized for the slope stability analysis. The Modified Bishop Method is a circular failure surface analysis. A minimum of 100 trial failure surfaces will be generated for each analysis, and the corresponding factors of safety will be calculated. After all the factors of safety are calculated by the slope stability model, the ten lowest factors of safety will be displayed and plotted on the sections shown in the computer-generated output. The results of the slope stability analysis will be presented in a written addendum to this Revised Report and a copy of the computer-generated output will be included for the Department's review. (Revised January 30, 2015)

Report

After completing the slope stability analysis, a report will be prepared that presents the results of the geotechnical evaluation of the eastern, southern, and western perimeter dikes.

The report will be prepared as an addendum to this Revised Report and will include a summary of the drilling activities and laboratory testing; a discussion of the subsurface conditions within the perimeter dikes; the results of the slope stability analysis; provide conclusions regarding the factors of safety of the dikes under static and dynamic conditions; and include a discussion of the impacts of the seeps on the stability of the eastern, southern, and western perimeter dikes. It will contain the test boring logs for TB-7, TB-8, and TB-9; the laboratory report; revised Figure 7 from this Revised Report showing the as-drilled location of the test borings; revised geological cross sections depicting subsurface conditions; and the computer-generated output for the slope stability analyses. (Revised January 30, 2015)

Slope Monitoring

Monitoring of the three slope indicators that will be installed in Test Borings TB-7, TB-8, and TB-9 to monitor the potential for slope movements during and after construction will occur following initial calibration of the slope indicators. The slope indicators will be monitored weekly during construction and monthly for two years following completion of construction. Manual monitoring will utilize the Slope Indicator Company Digitilt AT system or an equivalent system which allows for electronic transmission of monitoring information. PPG may request a reduction in monitoring at some point in the future, if warranted. (Revised January 30, 2015)

5.0 Updated Conceptual Site Hydrologic Model

Section 1.5 of this Report presented the conceptual site hydrologic model of the SLA that was initially developed for the Treatment Plan based on observations made during site visits, review of published geologic information, and review of groundwater information for the site from previous investigations. The purpose of developing the conceptual hydrologic model of the site was to provide a basis for identifying data gaps so that additional information needed to address them could be obtained during execution of the Treatment Plan. Data were also obtained to assist in identifying and evaluating potential remedial alternatives. Hydrologic data collected during implementation of the Treatment Plan that are used in developing the revised conceptual site hydrologic model include identification of the groundwater systems within the SLA, weekly flow measurements from the seeps and Drainage Ditch, flow measurements for water discharging from the drainage channel adjacent to the Pittsburgh and Shawmut Railroad tracks during part of 2012, rainfall, and information on capillary flow from the tensiometers installed for the revegetation evaluation. This information, along with the previously defined site geology, provided the basis for updating the site hydrologic model.

In considering the conceptual hydrologic model for the site, the following components of the hydrologic system in the area of the SLA must be considered:

- Surface water runoff from the SLA
- Shallow groundwater **consisting of leachate within and** limited to the immediate SLA **and the eastern end of the South Bench**
- Regional groundwater in bedrock
- Groundwater within the alluvium on the northern bank of the Allegheny River
- Groundwater within the areas of glacial soil on the northeastern corner of the SLA
- Precipitation, infiltration, evapotranspiration, and runoff

(Revised January 30, 2015)

5.1 Hydrologic Systems

5.1.1 Surface Water Systems

Glade Run is the primary receiving stream for storm water runoff from the SLA and the Western Slope. As described in Section 1.2 of this Report, the upper surface of the SLA slopes from east to west, and sheet flow runoff generally flows in that direction and discharges to Glade Run.

The Allegheny River and the Drainage Ditch are also receiving streams for runoff from the SLA, although the water carried in these streams is largely from other watersheds. Runoff from the SLA to the Allegheny River is from the watershed that is limited to the outslope of the dike above the South Bench and the South Bench itself. This area, which totals approximately nine acres, is insignificant compared to the overall Allegheny River drainage basin. The Drainage Ditch receives runoff from the outslope of the eastern dike wall, which has a watershed that occupies approximately two acres. The largest component of runoff to the Drainage Ditch is from the watershed area north of State Route 128. This watershed area is approximately 30 acres, or approximately 94 percent of the watershed area of the Drainage Ditch.

5.1.2 Shallow Groundwater System (Leachate)

Water levels **(leachate)** measured within the piezometers that were installed into the SLA as part of the Treatment Plan implementation and in previously installed piezometers establish the presence of a shallow groundwater system **consisting of leachate** in the source material and the perimeter dikes that comprise the former slurry lagoons. Depth to groundwater was measured in the piezometers during the period June 29, 2009 to June 20, 2011 (Table 3). The elevations representing the overall lowest groundwater table condition in the SLA during the period of measurement and the elevations representing the overall highest groundwater table condition were used to construct groundwater contour maps. Figure 15 is the seasonal low groundwater table map based on the November 9, 2010 water level measurements, and Figure 16 is the seasonal high groundwater table map based on the May 20, 2011 water level measurements. Seasonal low and high groundwater contour maps were constructed to define the groundwater drainage areas, to show the direction of groundwater flow, and to show the change in the groundwater drainage areas as groundwater levels fluctuate between high and low elevations. Figures 15 and 16 also show groundwater flow lines and the defined groundwater drainage areas as discussed in Section 2.4.5. The seasonal low and high groundwater tables are also shown on the geologic cross sections in Figures 9 through 14. **(Revised January 30, 2015)**

The response of the groundwater table within the SLA to rainfall was evaluated by comparing the groundwater elevations shown on Table 3 with the rainfall information shown on Table 4. The objective of the evaluation was to determine the role that precipitation plays in the rate at which the groundwater table fluctuates in the SLA. Review of Table 3 shows that the groundwater table within the SLA fluctuates slowly and seasonally rather that rapidly following the significant precipitation events shown on Table 4. The groundwater table within the SLA follows a normal pattern for aquifers in Pennsylvania with high groundwater conditions generally occurring in late winter (February to March) and low groundwater conditions generally occurring in late summer to early fall (September to October).

As discussed in Section 2.4.5 and as shown on Figures 15 and 16, shallow groundwater flow in the SLA is essentially radial with overall flow directions to the east toward the Drainage Ditch, the south toward the South Bench, and west toward the Western Slope. The chemistry of the seeps was evaluated relative to the chemistry of the ~~shallow groundwater~~ **leachate** within the

SLA and to qualitatively evaluate the solubility of the source material. **As described in Section 3.7, leachate samples were collected from within the SLA for analysis in May 2014. The analytical results for this sampling event are presented in Appendix S.** The chemistry of the seeps is being monitored on a weekly basis as required by the AO. The following table shows the range of pH values and concentrations of aluminum, arsenic, chromium, iron, lead, and antimony in the source material (Table 7) and the average, minimum, and maximum concentrations of the pH and same six metals in the seeps (Appendix H, Table 4) **and in leachate sampled in 2014**. (**Revised January 30, 2015)**

Comparison of pH Values and Total Metals Concentrations in the Source Material, ~~and~~ Seep Water, and Leachate

Parameter	Source Material(1)	Seep Water(2)	Leachate (6)
pH(3)	10 - 11.3	9.0 – 12	9.8 - 11.7
Aluminum(4)	104 – 961	59 - 8,770 (1,185)	9.7 - 5,200 (676)
Arsenic(4)	1.1 - 32.8	9 - 1,440 (178)	10 – 47 (18)
Chromium(4)	24.6 – 104	0.58 - 5.4 (2.0)	2.9B – 37 (9.3)
Iron(4)	5,120 - 18,900	160 - 24,200 (1,763)	42JB - 1,800 (724)
Lead(4)	1.2 – 487	1.3 - 2,040 (180)	1.2B – 540 (162)
Antimony(4)	ND(5) – 7.8	1.22 - 344 (47)	9J – 55 (37)

(1) Range of pH values and concentrations in the source material.

(2) Minimum-maximum and (average) values for all seeps, except for pH.

(3) Standard pH units.

(4) Concentrations of source material are in milligrams per kilogram and concentrations of seeps and SLA leachate are in micrograms per liter.

(5) ND = Not detected.

(6) Leachate samples collected from select SLA piezometers in May 2014.

As shown on the table, the pH of the source material and the pH of the seep water generally correspond to one another although there is a wider range of pH values in the seep water **and leachate.** Lower pH values in the seep water generally reflect a dilutional effect due to mixing of runoff during precipitation events. The highest pH values generally occur in Seep 105 and the water in the Drainage Ditch where the pH of the water is in the range of 10.5 to 12; otherwise, the pH of the seep water is generally in the range of 10 to 11 **and the pH of the leachate sampled is most frequently greater than 11**, which generally agrees with the pH of the source material. A comparison of the metals concentrations in the source material and the metals concentrations in the seep water indicates that the overall low concentrations of metals in the seep water generally suggest that the solubility of the metals in the source material is relatively low. **Conversely, the concentrations of metals in leachate samples are generally lower than those measured in seep water. (Revised January 30, 2015)**

To support the evaluation of an internal interceptor trench remedial alternative, hydraulic conductivity testing of this leachate system was completed using rising and falling head slug

tests in February 2014. A summary of the testing, results, and hydrogeological interpretation is presented in Appendix T. Most of the hydraulic conductivity (K) values observed in piezometers screened within SLA source material ranged from 0.094 to 1.205 feet per day. These values align with literature values for sand and silt mixture as was predominantly observed in borings completed along the proposed interceptor trench alignment. (Revised January 30, 2015)

5.1.3 Groundwater in Bedrock

Previous investigations by D'Appolonia in 1971 and Baker Environmental in 1993 established the presence of a groundwater system in bedrock. **D'Appolonia's report, which was submitted with the June 25, 2014 Response Letter in response to Comment No. 8 in the Department's May 13, 2014 Comment Letter and is contained in Appendix O of this Revised Report, determined that groundwater is present within bedrock underlying the SLA and concluded that groundwater flow appears to be downward (from the source material into bedrock) based on the chemistry of groundwater samples collected in piezometers that were installed as part of the study, although the report indicated this to be inconclusive. The report concluded that the principal source of water present in the former slurry lagoons is from infiltration.** ~~D'Appolonia's report determined that groundwater is present within bedrock underlying the SLA and concluded that groundwater flow appears to be downward (from the source material into bedrock) based on the chemistry of groundwater samples collected in piezometers that were installed as part of the study.~~**(Revised January 30, 2015)**

Baker Environmental installed four groundwater monitoring wells in bedrock in the SLA (see Figure 5 **and Appendix P, which was submitted with the June 25, 2014 Response Letter in response to Comment No. 8 in the Department's May 13, 2014 Comment Letter)**. MW-7 was installed within the SLA, MW-8 was installed on the northern edge of the SLA, MW-9 was installed beyond the Western Slope, and MW-11 was installed between the Pittsburgh and Shawmut Railroad tracks and the Allegheny River. **All four bedrock wells were observed to produce water.** ~~Groundwater was confirmed to be present in bedrock underlying the SLA in MW-7.~~ It is likely that groundwater in bedrock beneath the SLA exists in an unconfined condition because the quarrying that was performed exposed bedrock at the bottom of the former slurry lagoons. Based on the test boring information combined with the general chemistry of the water (pH of 6.43 and specific conductance of 525 micromhos per centimeter), it can be concluded that there have been no adverse impacts from the former slurry lagoons to groundwater in bedrock. The three wells installed into bedrock outside the limits of the slurry lagoon (MW-8, MW-9, and MW-11) confirm the presence of groundwater in bedrock in those areas. This groundwater is assumed to be regional in that it occurs in bedrock over a relatively large area compared to the area of the SLA. Analytical results for water samples collected from the three wells installed outside the SLA do not show any adverse impacts from the former slurry lagoons, based on the general chemistry of the water. The general chemistry of the above-referenced three bedrock groundwater monitoring wells indicates pH values in the range of 7.07 and 7.77 and specific conductance values in the range of 300 and 490 micromhos per centimeter**.** ~~If groundwater in bedrock had been impacted by the former slurry lagoons,~~ **These values are in contrast to** pH values of 10.0 or above and specific conductance values in the thousands of micromhos per centimeter ~~would be expected.~~ **that were observed in the former SLA (Appendix P). (Revised January 30, 2015)**

The groundwater elevations in the monitoring wells installed by Baker Environmental indicate that the overall direction of groundwater flow in bedrock underlying the SLA is southeast toward the Allegheny River. This is in the same direction as the bedrock dip and the same flow direction postulated in the conceptual site hydrologic model. Therefore, groundwater elevations collected by Baker Environmental confirm the general southeastward flow direction of groundwater in bedrock. There is also a topographic component controlling the southward flow of groundwater in bedrock. The bottoms of the former slurry lagoons are in the range of 90 to 115 feet above the pool elevation of the Allegheny River. Shallow groundwater flow in bedrock is commonly controlled by topography. Therefore, it is reasonable to assume that topography also plays **an important** role in the southeastward direction of shallow groundwater flow in bedrock. **(Revised January 30, 2015)**

The general chemistry of groundwater in MW-7 also suggests that upward groundwater gradients could exist beneath the former slurry lagoons because this groundwater has not been impacted by the ~~shallow groundwater~~ **leachate** ~~existing~~ within the former slurry lagoons. If downward gradients existed, it is likely that the general chemistry information would show some impact. Moreover, the pH of the groundwater in MW-7 (6.43) is lower than the groundwater in nearby upgradient Well MW-8 (7.20) which further suggests no impact to regional groundwater beneath the former slurry lagoons and supports the conclusion that upward groundwater gradients may exist in bedrock beneath the SLA. As indicated above, it is also likely that there is a lateral component of groundwater flow into the former slurry lagoons because the area north of State Route 128 represents a relatively large recharge area, and bedrock in this area dips southward toward the SLA. Therefore, groundwater in bedrock north of State Route 128 flows in the direction of the SLA. **(Revised January 30, 2015)**

Water is present on the interbedded shale and sandy shale outcrop adjacent to the Pittsburgh and Shawmut Railroad tracks southeast of the SLA (see Figure 2). A light gray to buff-colored precipitate is present on this outcrop as was present in seep areas on the South Bench and Western Slope suggesting that the source of the water is the SLA. Visual inspection of the outcrop indicates that groundwater is not discharging from the shale and sandy shale beds comprising the outcrop; rather, the groundwater appears to be discharging from the soil and bedrock interface at the top of the outcrop and it cascades down the outcrop. During installation of the IAS in 2009, shallow groundwater flow was observed to be discharging from weathered and fractured sandstone exposed in the trench that was excavated for the conveyance pipe from the weir bypass structure to the junction box. This shallow groundwater flow was intercepted in a French drain that was installed in the pipe trench so that it could be collected in the conveyance pipe and discharged to the junction box for neutralization. Based on the observation that groundwater is discharging at the soil and bedrock interface at the top of the shale and sandy shale outcrop, it is concluded that shallow groundwater flow also occurs below the pipe trench, discharges at the top of the shale and sandy shale outcrop, and cascades over it to a surface water collection channel adjacent to the railroad tracks.

ARCADIS installed two bedrock wells upgradient from the shale and sandy shale outcrop adjacent to the railroad tracks. The bedrock wells were intended to further assess shallow groundwater flow in the uppermost fractured bedrock units on the eastern side of the South Bench as well as measure the depth to the phreatic surface in deeper bedrock. Assessment of the depth to groundwater and the impact of pH on groundwater seepage in the uppermost fractured and in the deeper bedrock comprised this evaluation. The two bedrock wells, MW-20 and MW-21, are situated at locations judged to be hydraulically upgradient from the interbedded shale and sandy shale outcrop evidencing impacted seepage adjacent to the railroad tracks. The two wells are screened at depth intervals consistent with the elevation of the outcrop. MW-20 and MW-21 are screened approximately 810 to 795 feet msl and 835 to 820 feet msl, respectively (Appendix A). MW-20 communicates with groundwater deeper in bedrock whereas MW-21 communicates with shallow groundwater in the upper fractured bedrock zone. The elevation of the shale and sandy shale outcrop is approximately 800 to 830 feet msl. (Revised January 30, 2015)

Observations from the two bedrock wells support the conclusion that conditions at the outcrop predominantly reflect impacted groundwater in the soil and upper fractured bedrock on the eastern end of the South Bench and not the presence of leachate and seepage in groundwater deeper in bedrock, as follows:

- **The most recent pH assessment of groundwater in the two bedrock wells indicated a pH of 7.6 and 8.3 in MW-21 and MW-20, respectively. The near neutral pH in groundwater deeper in bedrock indicates no recognizable leachate impact in bedrock at the southeastern corner of the south bench;**
- **The deeper well (MW-20) has generally been dry with only little groundwater recharge into the well over time. This low recharge rate indicates the absence of water bearing fractures at an elevation corresponding to the elevation of the observed seepage from the shale and sandy shale outcrop;**

- **MW-21 produces water and indicates that the shallower portions of bedrock are more highly fractured. Water is likely seeping out of the rock at the upper portions of the outcrop; however, this water does not appear to be materially impacted by leachate or may be mixing with some shallow groundwater in fractured bedrock that has not been impacted by leachate.**
- **The result of the evaluation performed in MW-20 and MW-21 supports and confirms the conclusion in the December 2012 Report that the SLA-impacted seepage emanating from the shale and sandy shale outcrop adjacent to the railroad tracks flows through the soil and shallow fractured bedrock on the eastern end of the South Bench and is an important element of the overall evaluation of remedial alternatives.**

The following table summarizes the pH and groundwater elevation measurements in MW-20 and MW-21 in 2014:

Groundwater Elevations and pH Measurements in Bedrock Wells

Well	Date	Groundwater Elevation (feet msl)	pH (field measured)	pH (laboratory measured)
MW-20	3/11/14	NM	10.04	NA
	3/12/14	813.81	9.78	NA
	3/13/14	795.65	9.26	NA
	3/18/14	DRY	DRY	DRY
	4/1/14	DRY	DRY	DRY
	7/23/14	797.64	7.64	7.17
MW-21	3/12/14	838.31	10.40	NA
	3/13/14	839.02	9.37	NA
	3/18/14	838.94	9.56	NA
	4/1/14	839.51	9.58	9.91 [9.19]
	7/23/14	837.93	8.27	8.14 [8.09]

msl – Mean sea level.
NM – Not measured.
NA – Not applicable.

(Revised January 30, 2015)

Key Environmental measured the flows at culverts through which the water in the drainage channel adjacent to the Pittsburgh and Shawmut Railroad tracks discharges. Measurements were made from April 27, 2012 through October 2012 and determined that the average flow rate of the water discharging from the channel is 8 gpm. Inasmuch as this water is discharging from the SLA, it ~~must be~~ is considered in the site hydrologic model described in Section 5.2 of this Report. **(Revised January 30, 2015)**

5.1.4 Groundwater in Alluvium

Baker Environmental installed two monitoring wells, MW-10 and MW-12, into the alluvium that is present between the Pittsburgh and Shawmut Railroad tracks and the Allegheny River. The presence of groundwater within these wells confirms the presence of groundwater in the alluvium. However, the alluvium is physically separated from the SLA, and there is no indication of a **leachate impact** between the former slurry lagoons and the alluvium. **(Revised January 30, 2015)**

5.1.5 Groundwater in Glacial Soil

~~Shaw~~**CB&I** installed Piezometer PZ-14 in the northeastern corner of the SLA to determine if glacial soil underlies that area and to determine if groundwater is present in the glacial soil. Approximately 33 feet of glacial soil was encountered in the test boring for PZ-14 and groundwater was determined to be present at a depth of 7 to 8 feet bgs. Glacial soil was also encountered to a depth of approximately 30 feet bgs in the test boring for Monitoring Well MW-6 installed by Baker Environmental, and glacial soil was encountered in the test boring for PZ-15 that was installed by ~~Shaw~~**CB&I**. Groundwater was also encountered in the glacial soil in PZ-15. **(Revised January 30, 2015)**

As shown on Geologic Cross Section C-C' (Figure 11), glacial soil is in physical contact with the source material in the slurry lagoon and there is a hydrologic connection between the glacial soil and the source material. Cummings Riter recognized this hydraulic connection and estimated, based on the characteristics of the glacial soil as encountered in test borings, that the glacial soil **and bedrock units along the northern side of the SLA were** ~~was~~ contributing groundwater to the source material at a rate of 5 to 9 gpm. **(Revised January 30, 2015)**

5.1.6 HELP Model Input Parameters

The site hydrologic model presented in Section 5.2 will consider ~~shallow groundwater~~ **leachate** flow in the SLA as well as groundwater flow in bedrock and the glacial soil. The HELP model will be used to determine seepage rates for the ~~shallow groundwater~~ **leachate** in the SLA. This model requires a number of input parameters, including but not limited to hydrologic information such as rainfall, evapotranspiration, hydraulic conductivity, and groundwater flux. Moreover, the model has the ability to select values for these parameters based on the geographic location of the disposal facility. **(Revised January 30, 2015)**

Rainfall measurements were collected from a rain gauge installed on the SLA as part of the Treatment Plan implementation. Rainfall measurements were made from the period June 17, 2009 through June 24, 2011. Table 4 is a summary of the rainfall amounts over the period of measurement. For the period July 1, 2009 through June 30, 2010 (one calendar year), the total measured rainfall was 36.59 inches, and for the period July 1, 2010 through June 24, 2011 (one calendar year), the total measured rainfall was 38.54 inches. The average annual rainfall for the City of Kittanning is 36.85 inches (from Internet derived information for the City of Kittanning), which generally agrees with the rainfall quantities measured during this investigation.

The HELP model selected an annual rainfall of 38.1 inches as a default value for the area in which the SLA is located. The information obtained from recording the rainfall in the SLA for a period of two years and the average annual precipitation for the City of Kittanning suggests that the default rainfall value selected by the model is reasonable.

Comment No. 11 in the Department's May 13, 2014 Comment Letter requested an estimate of precipitation using a designated storm event to substantiate that precipitation falling on top of the SLA is a major source of infiltration. As explained in the response to Comment No. 11 in the June 25, 2014 Response Letter (Appendix Z), it would be more appropriate to evaluate precipitation patterns in evaluating infiltration into the SLA than selecting a storm event to substantiate and qualify the description of the plateau area being a major source of recharge to the seeps. Moreover, in the context of the HELP model, which calculates total annual discharge from the seeps, annual precipitation is the appropriate input parameter. (Revised January 30, 2015)

The HELP model also calculates or assigns the infiltration, evapotranspiration, and runoff values based on input parameters that include type and depth of soils, surface topography, geographic location (latitude and longitude), and hydraulic conductivity.

In constructing the HELP model for existing conditions, the types and depths of soils were determined for the cover soil placed on the SLA and for the source material based on information obtained from the test borings, test pits, and grain size analyses performed in the laboratory. The topsoil and source material are comprised of sandy to clayey silt. The average thickness of the topsoil was estimated to be four inches based on the measured thickness in the split-barrel samples for the piezometer test borings and of the exposed topsoil layer in the test pits. An average thickness of 25 feet (300 inches) was used for the source material based on test boring information. The average saturated thickness of 180 inches was determined from the depth-to-groundwater measurements in the piezometers made between April 6, 2009 and June 20, 2011. Surface topography was measured for the upper surface of the SLA and determined to be approximately 0.5 percent. A hydraulic conductivity of 1.65×10^{-2} centimeters per second was used for the fractured source material, which is within the range of hydraulic conductivities for fractured bedrock as published in "Groundwater" by Freeze and Cherry. An average groundwater flux of 7 gpm **for the area north of the SLA** was used in the model based on information developed by Cummings Riter. **A copy of the groundwater flux calculation brief is contained in Appendix N.** Model-calculated values of 7.3 inches per year for infiltration, 22.9 inches per year for evapotranspiration, and 7.8 inches per year for runoff were obtained from the HELP model. **(Revised January 30, 2015)**

The tensiometers that were installed for the revegetation study demonstrated that soil water is available for root uptake in the transpiration process. Therefore, the evapotranspiration value used in the HELP model is considered to be representative of site conditions as soil groundwater is available for root uptake.

5.2 Site Hydrologic Model

Three distinctively different but interconnected hydrogeologic systems have been identified in the SLA. These hydrogeologic systems include the deeper system in bedrock, the localized area underlain by glacial soil on the northeastern corner of the SLA, and the shallow **groundwater** (**leachate)** system within the source material in the immediate SLA. The deeper system in bedrock, likely the Freeport and Upper Worthington Sandstone units, represents regional groundwater whose recharge, flow, and discharge are controlled by geologic structure and topography. Recharge of groundwater in bedrock is primarily from infiltration in the area north of the site. Bedrock monitoring wells installed by Baker Environmental confirm that groundwater in bedrock flows in an overall southeastward direction toward the natural groundwater discharge zone in the Allegheny River. The close proximity of the SLA to the Allegheny River combined with the quarrying of bedrock provides conditions where regional groundwater in bedrock may be recharging the shallow groundwater system in the SLA by lateral flow and at times possibly vertically upward gradients beneath the SLA. **(Revised January 30, 20115)**

The shallow groundwater system is limited to the source material and dikes in the immediate SLA. Topographically, the SLA is essentially a plateau that has a very gently westward sloping upper surface and steep outslopes that fall to topographically lower areas on the eastern, southern, and western sides. The northern side of the SLA is bounded by a roadside drainage channel located between State Route 128 and the northern side of the SLA. To the east, the SLA dike descends into the Drainage Ditch. To the south, the SLA dike slopes downward to the Allegheny River, and to the west, the SLA dike descends to the floodplain of Glade Run and associated wetlands. This plateau acts as its own shallow hydrologic system in that precipitation falling onto the former slurry lagoons is the major source of recharge to groundwater within the lagoons. There is little if any off-site run-on onto the former slurry lagoons. Groundwater in glacial deposits and bedrock units north of State Route 128 is also a source of subsurface recharge into the former slurry lagoons, and groundwater inflow from the glacial deposits was estimated by Cummings Riter to be in the range of 5 to 9 gpm. An average groundwater inflow rate of 7 gpm was used for the HELP model.

Precipitation infiltrating the former slurry lagoons and any groundwater recharge within the subsurface provide the primary sources of water that contribute to the ongoing seepage from the SLA and also contribute to the base flow of the Drainage Ditch. Groundwater within the SLA flows radially toward the east, south, and west, discharging into the Drainage Ditch on the east and onto the slopes on the southern and western sides of the former slurry lagoons. The groundwater contour maps showing the groundwater drainage areas (Figures 15 and 16) have arrows depicting the radial groundwater flow directions in the SLA. **(Revised January 30, 2015)**

The HELP model simulation was constructed to quantify the hydrologic water balance for the SLA under existing site conditions. The HELP model can be used as a predictive tool to estimate the reduction in seepage that may occur under one or more remedial alternatives, including **regrading**, complete capping, partial capping, and phytoremediation, as will be discussed in Section 8.2.3 of this Report. **(Revised January 30, 2015)**

Input used in constructing the HELP model is discussed in Section 5.1.7 of this Report. The HELP model construction and results are shown on Figure 17 and the computer-generated output is contained in Appendix J. The HELP model was constructed using the average groundwater elevation information for the three drainage areas delineated for the seasonal low and seasonal high groundwater conditions depicted on Figures 15 and 16. The average groundwater conditions within the shallow groundwater system yield the following groundwater drainage areas: 41.5 acres for Area 1 (Western Slope), 33.5 acres for Area 2 (South Bench), and 15 acres for Area 3 (Drainage Ditch). **(Revised January 30, 2015)**

As shown on Figure 17, under existing conditions and based on information collected during implementation of the Treatment Plan, the HELP model calculated an average seepage rate of 34 gpm. Based on the HELP model results for existing conditions, it is concluded that the source of seepage from the SLA is a combination of precipitation falling on the SLA and groundwater inflow through the glacial soils, through bedrock to the north of the SLA, and possibly into the bottom of the SLA through upward groundwater gradients. The HELP model results also confirm the conceptual hydrologic model for the SLA that the shallow groundwater system within the source material in the SLA is its own unique groundwater **(leachate)** system. **(Revised January 30, 2015)**

Although the HELP model calculated an average seepage rate of 34 gpm, actual seepage rates for the SLA were evaluated as a reality check for the HELP model results and as a means of evaluating the remedial alternatives discussed in Section 7.0 of this Report. Seepage flows measured weekly in accordance with the AO (Appendix H), discharges from Outfall 001, and the water accumulating in the drainage channel adjacent to the Pittsburgh and Shawmut Railroad tracks provide important information on the overall seepage from the SLA. The weekly seep flow rate information was analyzed to determine the maximum, minimum, and average flows since measurements began on April 6, 2009. A review of the weekly flow rate data for the seeps indicates that since flow measurements were started, the maximum flow rate was approximately 580 gpm on May 8, 2012; the minimum flow rate was 1.2 gpm on January 5, 2010; and the mean flow rate is approximately 29 gpm after adjusting the data to exclude extreme weather-related flows. For example, due to the physical configuration (topography) of the areas where the seeps occur, water from some seeps may at times mix with water from other seeps, which imparts a bias to the measured flow rates when this mixing occurs. The maximum flow rate for the seeps measured on May 8, 2012 was likely a result of a rainfall event that day during which 1.5 inches of rainfall occurred. Likewise, the minimum flow rate of 1.2 gpm on January 5, 2012 occurred after nine consecutive days when the temperature only rose above freezing on one day and there were two nights during that period of time when the nighttime temperature was 5°F and 6°F. The seeps were largely frozen on January 5, 2012 and flow rates could not be measured. Adding the average discharge of 8 gpm for the water collecting in the drainage channel adjacent to the Pittsburgh and Shawmut Railroad tracks results in an average seepage rate discharge from the SLA of 37 gpm.

The average measured flow rate of 37 gpm compares well with the 34 gpm computed by the HELP model. Therefore, HELP model calculated flow rates from the seeps compare favorably to the average measured flow rate and can be useful in predicting the effectiveness of certain remedial alternatives to be evaluated.

6.0 Water Quality Considerations

6.1 Current IAS Operations and Discharge Authorization

As originally designed, the IAS provides pH adjustment to treat seepage waters which represent the base flow of the Drainage Ditch (including Seep 105) combined with flows from Seeps 100, 103, 108, and 110 along the South Bench. Other seeps along the South Bench (including Seeps 4, 101, 102, 104, 109, S, and SE) are further addressed by passive treatment using strategically placed mulch beds. Similarly, seeps along the Western Slope (Seeps 6, 106, and W) are also being managed via this passive treatment application. Most recently, and as of August 2012, the base flow ~~of 5 gpm~~ associated with Seep 5 (South Bench) has been directed to the IAS for treatment. Based on available flow data, the calculated average effluent flow from the IAS has been approximately 27.2 gpm. Formal operation of the IAS commenced in February 2010. **(Revised January 30, 2015)**

Prior to the installation and startup of the IAS, the March 2009 AO (issued by the Department) outlined the water-based constituents of interest which PPG would be required to monitor (weekly) at the SLA. Aside from flow, these constituents include six metals (aluminum, antimony, arsenic, chromium, iron, and lead), TSS, O&G, and pH. In July 2009, and in conjunction with approval for construction of the IAS, the Department established interim discharge criteria for several of the constituents. Specific numeric criteria were assigned for pH (6.0 to 9.0), TSS (30 mg/L monthly average and 60 mg/L instantaneous maximum), and O&G (15 mg/L monthly average and 30 mg/L monthly maximum), which are acknowledged as non-binding values relative to a potential long-term remedy for the SLA. Monitor and report conditions were established for flow and the six metals. Since the February 2010 activation, the weekly analytical results from the IAS discharge (designated as Outfall 001) have been tabulated and provided to the Department in the form of required monthly submittals.

6.2 IAS Water Quality Assessment

Review of the analytical data collected thus far has afforded the opportunity to assess the overall water quality of the Outfall 001 discharge with respect to the constituents cited above. In the case of TSS, O&G, and pH, the reported effluent concentrations have been compared directly to the interim discharge criteria. Relative to the metals (for which numeric criteria were not assigned), the assessment was conducted in the context of evaluating any potential impacts to corresponding Pennsylvania water quality criteria (PA WQC). This was accomplished through the use of PENTOXSD, a predictive modeling tool that is recognized and accepted by the Department. Further discussion of the Outfall 001 effluent quality is provided in the sections that follow.

6.2.1 Total Suspended Solids

From the data reviewed (covering 134 weeks from February 2010 to August 2012), weekly TSS results have generally ranged from 2.5 to 25 mg/L, with a few isolated sampling events yielding values exceeding the instantaneous maximum discharge criterion (60 mg/L). At the Outfall 001 average discharge flow (27.2 gpm), these TSS concentrations translate to daily mass loadings to the Allegheny River ranging from approximately 0.8 to 8.0 pounds per day. For the occasions (12 of 134 samples) when TSS values have been outside this range, concentrations as high as 4,300 mg/L have been recorded. For these select samples, there has been no visual or turbidometric evidence which would suggest high concentrations of TSS at the time of sample collection.

Initially, these infrequent and aberrant TSS results were considered the possible result of solids introduction to the IAS due to storm water runoff, but this supposition was eventually ruled out because meteorological data showed no clear correlation with the dates of the affected samples. However, with the knowledge that the influent to the IAS contains appreciable dissolved silicon, it was speculated that the nature of these samples was being influenced by temperature reduction during transport to the laboratory, combined with subtle differences in pH and perhaps other indeterminate factors.

Accordingly, it was postulated that precipitation effects (involving silicon) during sample transport were responsible for the anomalous TSS concentrations observed at the time of laboratory analysis. Although the rationale for this phenomenon continues to be evaluated, a sample from July 2012 with an aberrant TSS concentration clearly exhibited the presence of a gel-like precipitate (upon receipt at the laboratory), and this precipitate was not present in the field when the sample was collected. Subsequent limited analysis of the precipitate revealed that it was comprised of 97 percent water and contained greater than 96 percent silicon on a dry-weight basis. This analytical quantification lends further support to the sample transformation theory and is the most plausible explanation for the TSS concentrations reported by the laboratory in the absence of corroborating evidence at the time of sample collection. Photographic documentation regarding the condition of the Outfall 001 effluent and the afore-mentioned gel-like precipitate, along with analytical results for the precipitate are provided in Appendix L.

Despite the few samples with aberrant TSS concentrations (which as noted continues to be investigated), the IAS effluent is generally compliant with the established interim discharge criteria, and calculated overall daily mass loadings of solids to the Allegheny River remain extremely small. Moreover, based on the limited characterization of the precipitate noted above, it is anticipated that the majority of the TSS is comprised of innocuous compounds associated with the presence of the silicon (the basic elemental component of sand).

6.2.2 Oil & Grease

The weekly results for O&G in the IAS discharge have demonstrated consistent compliance with the interim discharge criteria. Out of the 134 samples collected, measurable O&G levels were reported in only 14 samples at concentrations ranging from 1.37 to 8.62 mg/L. This range is well below both the monthly average and instantaneous maximum discharge criteria.

6.2.3 pH

As recognized, the principal objective of IAS operations is to facilitate the addition of acid to the collected SLA seep waters in order to achieve the required reduction in pH prior to discharge to the Allegheny River. The IAS has maintained successful treatment performance throughout its operation, providing for effluent pH values ranging from 6.68 to 8.97, which fall within the specified criteria of 6.0 to 9.0. The average pH of all IAS discharge samples reported to date is approximately 8.46.

6.2.4 Metals

As noted above, interim discharge criteria for metals in the IAS discharge were not previously established; however, all sample results for six specified metals are reported and transmitted to the Department. The PENTOXSD model was used to qualitatively assess potential water quality impacts posed by the metals concentrations in the IAS discharge. Discussion of key input parameters to the PENTOXSD model and the subsequent model predictions are provided in the sections below.

6.2.4.1 PENTOXSD Modeling Methodology/Input Parameters

The PENTOXSD Model (v2.0c, 2009) was utilized to evaluate the potential impacts of the Outfall 001 discharge into Pool No. 6 of the Allegheny River, adjacent to the SLA. To the extent available, site- and area-specific information was used in developing the model input parameters. Site- and area-specific information provides for greater confidence in the model predictions with respect to maintaining protection of the established ecological and/or human health WQC.

- Allegheny River Background Data – For the six metals of interest, several sources of data were reviewed to arrive at calculated values deemed representative of the background concentrations in Pool No. 6 of the Allegheny River. These sources included project-specific weekly monitoring data (April 2009 through April 2012) collected immediately upriver of the SLA; data from the USGS-Kittanning gaging station; and data from stations (located in Kittanning and Ford City) which are part of the Pennsylvania Surface Water Quality Monitoring Network. The calculated river background concentrations are listed below, with further details regarding their development shown in Table K.1 of Appendix K.
  - Aluminum = 369 µg/L
  - Antimony = 1.93 µg/L

- Arsenic = 3.9 µg/L
- Chromium = 11.8 µg/L
- Iron = 902 µg/L
- Lead = 2.2 µg/L

- Allegheny River Hydrodynamics – Beyond the background concentrations, other principal model inputs associated with the Allegheny River included dimensional aspects and flow conditions, as follows:

  - Critical Low-Flow – A value of 2,250 cubic feet per second (cfs) was input to represent the low-flow condition of Pool No. 6, as required by the model. This value is based on information previously obtained from the U.S. Army Corps of Engineers (USACE, 2007) and is predicated on the regulated nature of the river, following the construction of the Kinzua Dam. Note that the lowest flow measured in the Allegheny River during the weekly monitoring required by the AO was 2,317 cfs on August 2, 2011. Therefore, the low flow value used in the PENTOXSD modeling correlates well with the actual measured low flow.

  - River Depth – River bathymetry data received from the Western Pennsylvania Conservancy (WPC, 2012) was used to estimate an average river depth in the reaches of Pool No. 6 immediately adjacent to the site. Specific transects pulled from the WPC dataset spanned the river at River Miles 39.47, 39.63, and 39.95 and collectively yielded an estimated average depth of 13.85 feet which was input to the model.

  - River Width – The width across each of the three subject transects from above was used to calculate an average river width of 1,295 feet (specific to this portion of Pool No. 6) which was input to the model.

  - River Velocity – The remaining input parameter of river velocity was back-calculated by solving the relational equation "Flow = Depth x Width x Velocity." Plugging in the known values results in a calculated river velocity of approximately 0.13 foot per second which was input to the model.

- Outfall 001 Discharge Flow – A value of 27.2 gpm (0.039 million gallons per day) was input to the model to represent a combined flow from the IAS that also includes the contribution from Seep 5. Specifically, this value was derived from statistical analysis of weekly flow data over the period February 2, 2010 through April 24, 2012 and was done prior to the actual introduction of Seep 5 into the IAS in August 2012.

- Outfall 001 Discharge Concentrations – Based on flow-weighted contributions to the IAS, the metals concentrations (statistically derived upper bound values) in the pH-adjusted effluent at Outfall 001 were calculated to be:

  - Aluminum = 4,350 µg/L
  - Antimony = 62.4 µg/L
  - Arsenic = 202.4 µg/L

– Chromium = 18.5 µg/L
– Iron = 7,571 µg/L
– Lead = 158 µg/L

Note: These concentrations reflect mathematically derived and purposely conservative values for use as model inputs. When compared against actual data from the Outfall 001 discharge over the same time period (February 2010 through April 2012), calculated long-term monthly averages are seen to be: aluminum (784 µg/l); antimony (48.1 µg/l); arsenic (117.4 µg/l); chromium (essentially non-detect); iron (2,019 µg/l); and lead (120 µg/l).

6.2.4.2 PENTOXSD Model Results

Using the input values from above and based on model-generated partial mix factors (PMFs), the metals concentrations in the Outfall 001 discharge were assessed relative to maintaining protectiveness of the PA WQC, as defined in PA Code Title 25, Chapter 93. For the metals of interest, the most stringent WQC are ecologically driven for aluminum (acute criterion), chromium (chronic criterion), iron (chronic criterion), and lead (chronic criterion). The most stringent WQC for antimony and arsenic are associated with human health toxicity. The model-derived PMFs predicted that approximately 6 percent of the river would be available to assimilate Outfall 001 discharges during the 15-minute acute ecological criteria compliance time. Similarly, the Outfall 001 discharge is predicted to mix with approximately 44 percent of the river during the 720-minute compliance time associated with the chronic ecological and human health criteria.

The principal output from the model, in the form of predicted WQBELs, were compared to the metals concentrations in the Outfall 001 discharge. As tabulated below and further summarized in Table K.2 (Appendix K), the respective WQBELs are significantly higher than the Outfall 001 metals concentrations (model-input values). Additionally, there is an even more pronounced difference observed when the WQBELs are compared to the long-term monthly average concentrations noted above. The magnitude of these differences eliminates any potential concern that the corresponding PA WQC would be jeopardized by the current quality of the discharge. The complete results from the PENTOXSD model run are provided in Appendix K, along with other supporting information.

Constituent	Outfall 001 Modeled Discharge Concentration (µg/L)	Outfall 001 Long-Term Average Discharge Concentration (µg/L)	Model-Predicted Monthly Average WQBEL Concentrations (µg/L)
Aluminum	4,350	784	585,585
Antimony	62.4	48.1	59,827
Arsenic	202.4	117.4	99,441
Chromium	18.5	<18.5	1,070,000
Iron	7,571	2,019	20,580,000
Lead	158	120	5,274

6.2.4.3 PENTOXSD Factor of Safety

The PENTOXSD model predictions suggest no degradation of the Allegheny River water quality from the current Outfall 001 discharge with respect to the metals evaluated. However, within the model framework, a Factor of Safety (FOS) can be applied to account for possible uncertainties in the input parameters. The FOS is an optional input and was left at the default value of 0 in the PENTOXSD run included in Appendix K. If an added layer of conservatism is desired, an FOS in the range of 0.2 to 0.5 could be input to the model run and accordingly reduce the predicted WQBELs by 20 to 50 percent. These reductions would still maintain a sizable buffer between the WQBELs and the current metals concentrations in the Outfall 001 discharge and provide for continued protection of the WQC. Particular consideration for applying an FOS would address possible uncertainties in future (increased) flows through the IAS.

6.3 Summary

Since the start of operations, weekly monitoring of the IAS discharges have enabled the compilation of an analytical database from which reasonable conclusions can be drawn regarding the nature and quality of the Outfall 001 water entering the Allegheny River. Clearly, O&G and pH (as amended in the IAS) do not represent any concerns in the IAS effluent. Relative to TSS, infrequent spikes have been recorded, but they are believed attributable to laboratory preservation techniques (a sample transformation phenomenon involving silicon precipitation and other factors) that continue to be evaluated. With respect to discharge conditions, actual TSS values are more truly represented by the tighter range of concentrations encompassing the majority of the samples collected to date. As for the metals, PENTOXSD model predictions offer significant confidence that applicable WQC are being fully protected. On the whole and with respect to the parameters identified in the AO and evaluated herein, the discharge from the IAS represents an inconsequential contribution to the Allegheny River. **This conclusion remains valid for the discharges from the Enhanced Collection and Treatment system discussed in subsequent sections.**

In Comment No. 2 of the May 13, 2014 Comment Letter, the Department indicated that it would perform independent modeling upon submission of the NPDES permit application. The Department further indicated that any proposed draft NPDES permit may include conclusions based upon studies that were performed under the Plan. PPG acknowledges that the Department will perform independent modeling as part of the NPDES permitting process. PPG will submit the NPDES permit application by March 31, 2015. (Revised January 30, 2015)

7.0 Water Treatment Technology Considerations

~~Based on the water quality discussion presented in Section 6.0, there is no compelling evidence to support the need~~ **The extent to which there is a need** for additional treatment of the SLA Outfall 001 effluent beyond that which is currently provided in the IAS **will be addressed in the context of the NPDES permitting process**. Nonetheless, this section of the report gives consideration to technology and technology-based effluent limitation guidelines (ELGs) to determine their potential relevance or applicability to the six metals of interest for the SLA. The review focuses on ELGs as published in the Code of Federal Regulations (CFR), along with other discharge standards which have basis or make reference to the federally published ELGs. Following the ELG discussion, additional information is provided with regard to preliminary treatability tests conducted on site-specific seep samples collected from the SLA. **(Revised January 30, 2015)**

7.1 Effluent Limitation Guidelines

7.1.1 Published Industrial Category ELGs

As codified in the federal regulations, ELGs have been promulgated for specific process/waste streams generated from current or proposed operations within a defined industrial category. The seeps emanating from the SLA cannot reasonably be associated with an industrial category in the federal regulations, but rather constitute a discharge derived as a result of water contact with former glass production residuals—more appropriately, an effluent being treated/discharged as part of an interim remediation activity. Although not strictly applicable to the SLA seeps, 40 CFR §426, Subpart D (Plate Glass Manufacturing Subcategory) was reviewed to determine if ELGs existed for any of the six metals of interest for the site. The Plate Glass Manufacturing Subcategory was deemed to be most closely associated with the origin of the process residuals at the SLA. As a result of this review (specific to 40 CFR §426.42), ELGs were identified only for the conventional parameters of pH and TSS, and within the scope of best practicable control technology currently available. The ELG assigned for pH in 40 CFR §426.42 is 6.0 to 9.0 standards units, and the ELG for TSS is 2.76 pounds per ton of product manufactured as a 30-day average and 5.55 pounds per ton of product manufactured as a one-day maximum.

Considering the physical nature of the SLA (i.e., containing materials placed into the subsurface), an additional scan of potentially applicable industry categories resulted in examination of 40 CFR §445 (Landfill Point Source Categories) for both hazardous (Resource Conservation and Recovery Act [RCRA] Subtitle C) and non-hazardous (RCRA Subtitle D) landfills. Although the SLA does not meet the definition of a landfill within the context of the regulations, a review was still undertaken in an attempt to identify ELGs that are applicable to sites with comparable physical conditions. ELGs for Subtitle D Landfills (40 CFR §445.23) have not been promulgated for any of the six metals of interest for the SLA; however, ELGs for Subtitle C Landfills (40 CFR §445.13) include two of the metals of interest: arsenic and chromium. The published values, stated as maximum monthly averages, are deemed to represent the application of best available technology economically achievable for landfill leachate. The Subtitle C Landfill ELGs for arsenic and chromium are 540 µg/L and 460 µg/L, respectively, both of which are greater than the long-term monthly average IAS discharge concentrations **and the SLA leachate concentrations** for these constituents. **(Revised January 30, 2015)**

7.1.2 Remediation General Permit ELGs

With the obvious challenges to find a comprehensive and comparable set of ELGs within the published industry classifications, efforts were directed to identify possible technology-based effluent limits arrived at through application of best professional judgment. These efforts led to review of general remediation permits, and ultimately in the review of the Remediation General Permit (RGP) developed by Region 1 of the USEPA and subsequently adopted in the states of Massachusetts (Permit MAG910000) and New Hampshire (Permit NHG910000) for regulation of discharges under the NPDES program. The RGP first became effective in September 2005 and was reissued most recently in September 2010. The technology-based effluent limitations included in the RGP were developed by the USEPA (using best professional judgment) to meet the requirements of best available technology for toxic pollutants. In essence, the values in the RGP represent federally derived ELGs aimed at the category of water-based remediation projects, and as such, are relevant to consideration of the ongoing activities at the SLA. Specific to the terminology used in the RGP, the SLA would most closely correspond to a "Non-Petroleum Primarily Heavy Metals Site."

The original USEPA Fact Sheet (published in 2004) which introduced the proposed RGP and solicited public comments was studied to gain a further understanding of the application of the effluent limitations to actual remediation project sites. The most recent version of the RGP (effective September 2010) was also reviewed to ensure that originally proposed relevant components (discussed in the Fact Sheet) had been maintained. Within the RGP, effluent limits have been established for five of the six metals of interest at the SLA; they include antimony, arsenic, chromium, iron, and lead (aluminum is not addressed in the RGP). In most cases, these limits are generally predicated on WQC, relying on adoption of the most stringent acute or chronic aquatic criterion, and with consideration of proven performance of current treatment technologies. Additionally, and for metals only, numeric effluent limitations are expressed to account for both zero-dilution and dilution-influenced conditions in the receiving waters.

Accordingly, Appendix III of the RGP lists the metals effluent limitations under zero-dilution conditions, with further breakdown corresponding to freshwater or saltwater discharges. Recognizing that certain metals are hardness-dependent, the State of Massachusetts freshwater limits (based on hardness = 50 mg/L) constitute the most reasonable representation of the local Allegheny River setting (hardness = 88.5 mg/L). Within the context of the RGP, the Appendix III effluent limits would first be compared against a site's baseline discharge concentrations under zero-dilution conditions. If the site's baseline concentrations exceed any of the Appendix III limits, and the discharge is known to be entering a receiving water body with available dilution volume, then Appendix IV of the RGP becomes applicable.

To utilize the effluent limits in Appendix IV of the RGP, an appropriate dilution factor must be calculated, as follows (using State of Massachusetts equation):

Dilution Factor = (Discharge Flow + Receiving Stream Q7-10 Flow)/Discharge Flow
[with all flows expressed in cfs]

Once the Dilution Factor is determined, the corresponding effluent limitations can be selected from the table in Appendix IV of the RGP. As observed, these effluent limitations progressively increase as the Dilution Factor increases, but reach a maximum value (never to be exceeded regardless of dilution) designated as the "Ceiling Value." The Ceiling Values are directly obtained from previously promulgated ELGs, found in 40 CFR §433.14 (Chromium and Lead); in 40 CFR §437.42 (Antimony); and in 40 CFR §445.11 (Arsenic), and prevent unbounded increases in effluent limitations due to "infinite" dilution. The Ceiling Values are as follows:

- Antimony = 141 µg/L (daily maximum)
- Arsenic = 540 µg/L (monthly average)
- Chromium = 1,710 µg/L (monthly average)
- Iron = 5,000 µg/L (daily maximum)
- Lead = 430 µg/L (monthly average)

Given the current IAS discharge flow (27.2 gpm) and the significant amount of dilution provided by the Allegheny River (on the order of 37,000-fold at full mixing with the critical low-flow condition [2,250 cfs]), these Ceiling Values have the highest degree of applicability to the evaluation of potential treatment effectiveness for metals at Outfall 001. Even under partial river mixing conditions (in line with the PMFs generated by the PENTOXSD model; see Section 6.2.4.2), calculated Dilution Factors would still range from approximately 2,000 (Outfall 001 mixing with 6 percent of the river) to 16,500 (Outfall 001 mixing with 44 percent of the river). These Ceiling Values are all well below the PENTOXSD-predicted WQBELs (see Table K.2 in Appendix K) and thus would maintain protection of the PA WQC.

7.2 Treatability Testing

The results of the PENTOXSD modeling and the technology-focused regulatory review indicate the Outfall 001 discharge to be acceptable from both a water quality perspective, as well as when viewed against standards derived from the most comparable ELGs. However, it is recognized that the ELGs are based upon treatment technologies available for metals removal. In this regard, and to support the remedial alternative discussions in Section 8.0 of this Report, PPG commissioned the performance of a site-specific treatability testing program to determine the efficacy of providing a meaningful reduction in the concentrations of the metals of interest within the realms of technical and economic feasibility.

7.2.1 Background

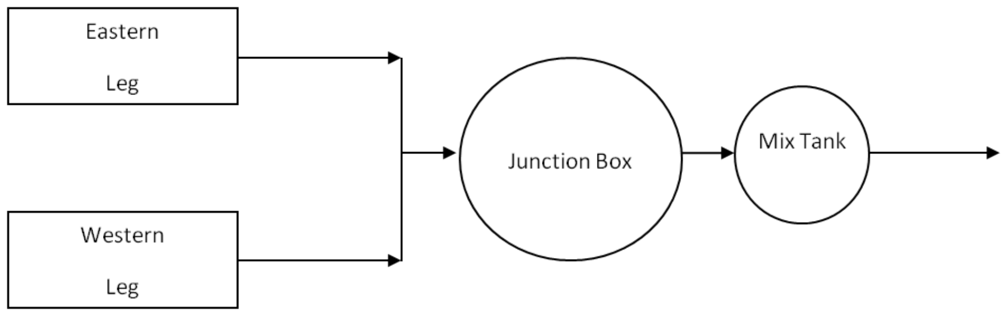
As previously noted in Section 6.1, the IAS provides for pH adjustment (through active neutralization) of the collected seep waters prior to their discharge to the Allegheny River via Outfall 001. The IAS installation was developed and implemented as an interim solution to expeditiously address the identified constituent of concern (pH) and provide additional time to gather data and evaluate other potential remedial alternatives during the execution of the approved Treatment Plan. Currently, the discharge authorization for Outfall 001 specifies interim discharge criteria for pH, TSS, and O&G (Section 6.1) and monitor/report conditions for aluminum, antimony, arsenic, chromium, iron, and lead.

The treatability testing program was focused on examination of potential applications for metals removal in the context of demonstrated available technologies. Of the six metals of interest, initial consideration was given to arsenic treatment technologies, with evaluation of possible overlapping benefits for lead removal and secondarily for the other metals. The treatability testing program was performed by Siemens with technical guidance/input provided by ~~Shaw~~**CB&I**. **(Revised January 30, 2015)**

In addition, ARCADIS performed supplemental treatability testing in 2014 to examine dissolved metals and silica removal applications in the context of demonstrated available and applicable technologies with specific focus on treatment of leachate water (i.e., groundwater) that would be collected. The treatability testing was performed in three phases, and additional testing is planned. The results of this supplemental treatability testing, including the objectives, procedures, and results are presented in Section 7.4 of this Revised Report. (Revised January 30, 2015)

7.2.2 Treatability Test Water (2009 – 2012)

Influent waters to the IAS are derived from the Eastern Leg (including the French drains installed on the South Bench east of the junction box) and Western Leg (channel that collects seep flows west of the junction box) SLA. As depicted below, the flows from these legs are combined within the junction box (where initial acid addition takes place) and are then routed to a mix tank (for final pH adjustment) before being discharged through Outfall 001. For purposes of the treatability testing, five gallons of raw, untreated water were collected from both the Eastern and Western Legs.



Upon receipt at Siemens' Roseville, Minnesota, facility, the individual Eastern and Western Leg samples were analyzed to provide for a characterization of the six SLA metals (total and dissolved) along with pH and silicon. The results from these analyses are summarized in the table below, which clearly shows that significant portions of the metals are present in the dissolved fraction and further suggesting that simple filtration would not be effective in their removal. Silicon was incorporated into the analytical characterization due to its confirmed presence (see Section 6.2.1) and potential solids-loading impacts on treatment processes. As instructed, Siemens then prepared a flow-proportioned composite sample corresponding to the historically observed (from available field data) ratio of 60 percent from the Eastern Leg and 40 percent from the Western Leg. The composite sample analytical results (pH and dissolved metals only) are also summarized in the table below. Ultimately, the composite sample was utilized in the ensuing treatability testing activities.

Constituent	Units	Eastern Leg		Western Leg		Composite (60:40)	
		Total	Dissolved	Total	Dissolved	Total	Dissolved
pH	S.U.	10.9	---	10.3	---	10.8	---
Aluminum	µg/L	< 500	< 500	590	< 500	---	< 500
Antimony	µg/L	94	94	38	34	---	70
Arsenic	µg/L	224	219	110	106	---	186
Chromium	µg/L	< 10	< 10	32	30	---	18
Iron	µg/L	610	< 500	1,070	650	---	2,030
Lead	µg/L	198	198	95	68	---	146
Silicon	µg/L	1,600,000	1,600,000	593,000	556,000	---	1,380,000

7.2.3 Treatability Testing Approach

The treatability testing program was conducted to provide preliminary data/information sufficient for purposes of screening and evaluation of potential remedial alternatives for the SLA seep waters, and to determine if possible applications of demonstrated available technologies would be feasible. As previously mentioned, treatment technologies for arsenic removal were given first consideration since this constituent can more often provide greater technical challenges than the other SLA metals of interest. Accordingly, the results of a literature search and subsequent screening for arsenic treatment technologies were factored into the development of the treatability testing approach. Recognized and published treatment processes for arsenic include the following:

Adsorption-Based Technologies

- Ion Exchange
- Activated Alumina
- Oxidation/Adsorption
- Alternative Adsorption Media (titanium-based, zirconium-based, iron-based)

Precipitation-Based Technologies

- Modified Coagulation/Filtration
- Modified Lime Softening
- Oxidation/Filtration

Other Treatment Technologies

- Electrodialysis Reversal
- Reverse Osmosis
- Coagulation-assisted Micro-filtration

Based on the above and consultation with Siemens, initial bench-scale tests (i.e., jar tests) were performed to evaluate adsorption-based technologies with varying types of media. The data generated from the bench tests were then utilized in the performance of column testing to further evaluate the predicted long-term performance characteristics of the media shown to be potentially most effective. Although arsenic was the principal target of these tests, the ability to remove lead and the other metals was also documented. Section 7.2.3.1 presents the bench-scale and column test results, and Section 7.2.3.2 provides discussion of results from a very cursory bench-scale test of a precipitation-based technology. Deemed to be cost-prohibitive, no consideration was given to potential evaluation of the three remaining technologies (Electrodialysis Reversal, Reverse Osmosis, **and** Coagulation-assisted Micro-filtration) as part of the treatability testing program. **(Revised January 30, 2015)**

7.2.3.1 Evaluation of Adsorption-Based Technologies

Two rounds of bench-scale tests were performed according to the following protocols:

Round 1 Bench Tests

- Using sulfuric acid, adjust the seep water (60:40 composite) pH to target 7 to 7.5

- Mix the seep water with the relevant treatment media for 20 minutes
- Filter the treated seep water and analyze for the constituents of interest
- Media used included ASG (titanium-based arsenic-specific media), SCU (trace-metals media), and CSO (cationic exchange resin)

Round 2 Bench Tests

- Using sodium hypochlorite, oxidize arsenic and iron in the seep water for 30 minutes
- Using sulfuric acid, adjust the seep water pH to target 7 to 7.5
- Mix the seep water with the relevant treatment media for 20 minutes
- Filter the treated seep water and analyze for the constituents of interest
- Media used included ASG, SCU, and CSO

The results of these bench tests are summarized in the table below and show that greater than 95 percent of the arsenic and approximately 85 percent of the lead were removed using the titanium-based ASG media. However, these ASG-media results also reveal that nearly 50 percent of the silicon was removed, thus rendering these adsorption sites unavailable for metals adsorption and generating a technologically and economically unacceptable media depletion rate. Antimony and chromium showed measurable reductions, with iron removal being observed to a lesser degree. The CSO resin was generally ineffective, and the precursor oxidation step offered minimal benefit to most metals, although iron appeared to respond somewhat favorably under these conditions with the SCU media.

Summary of Bench Test Results (Dissolved Metals Reported)

Constituent	Units	Untreated (60:40 Composite)	pH Adjust			Oxidation + pH Adjust	
			ASG	SCU	CSO	ASG	SCU
pH	S.U.	10.8	6.44	8.99	7.48	6.52	9.08
Aluminum	µg/L	<500	<500	<500	---	<500	<500
Antimony	µg/L	70	10	27	62	<10	31
Arsenic	µg/L	186	<10	81	174	<10	96
Chromium	µg/L	18	<10	15	18	<10	18
Iron	µg/L	2,030	1,530	1,460	---	1,380	650
Lead	µg/L	146	21	38	136	22	41
Silicon	µg/L	1,380,000	693,000	942,000	---	723,000	556,000

Column Tests

Following review of the bench test results, Siemens proceeded with column tests using the ASG media alone and in combination with the SCU media (ASG-column followed by SCU-column) utilizing seep water which had been adjusted to an approximate pH of 8.0. The results presented in the table below indicate that arsenic removal was slightly more effective with the ASG-SCU combination, but overall trends show that removal efficiencies begin to drop off as soon as 80 bed volumes (BV) have been passed. Lead concentrations in the effluent remained nearly steady for 120 BV but the removal was seen to be only on the order of 60 percent. It is assumed that the degree of silicon removal witnessed during the bench tests was also present in the column tests, and is in part responsible for the rapid decline in removal efficiency. The removal of antimony was most effective with the ASG-SCU combination, but performance had noticeably declined by the 120 BV interval. Chromium did not show any appreciable removal with either of the column media.

Summary of Column Test Results (Dissolved Metals Reported)

Constituent	Units	Untreated (60:40 Composite)	40 BV		80 BV		120 BV	
			ASG	ASG-SCU	ASG	ASG-SCU	ASG	ASG-SCU
pH	S.U.	8.1 (adjusted)	---	---	---	---	---	---
Aluminum	µg/L	<500	---	---	---	---	---	---
Antimony	µg/L	70	23	14	31	16	38	20
Arsenic	µg/L	186	3	2	21	7	39	14
Chromium	µg/L	18	16	17	18	17	18	18
Iron	µg/L	2,030	---	---	---	---	---	---
Lead	µg/L	146	56	45	61	53	60	55
Silicon	µg/L	1,380,000	---	---	---	---	---	---

7.2.3.2 Evaluation of Precipitation-Based Technologies

A preliminary bench-scale precipitation test was also performed using separate applications of magnesium hydroxide [$Mg(OH)_2$] and ferric chloride ($FeCl_3$). To support the test, untreated seep water was first adjusted to a target pH of approximately 8.0, and then individual sample aliquots were separately dosed with $Mg(OH)_2$ and $FeCl_3$. The results are presented in the table below, which indicate that $FeCl_3$ was fairly effective in removing iron (approximate 97.5 percent reduction), lead (approximate 93 percent reduction), and to a lesser degree for arsenic (approximate 76 percent reduction). Of particular note, $FeCl_3$ also removed nearly all (greater than 99 percent) of the silicon. With the exception of the observed iron and chromium removal, the use of $Mg(OH)_2$ was seen to be comparatively ineffective for dealing with antimony, arsenic, lead, and silicon.

Summary of Precipitation Test Results (Dissolved Metals Reported)

Constituent	Units	Untreated (60:40 Composite)	$Mg(OH)_2$	$FeCl_3$
pH	S.U.	8.1 (adjusted)	---	---
Aluminum	µg/L	<500	---	---
Antimony	µg/L	70	73	29
Arsenic	µg/L	186	190	45
Chromium	µg/L	18	<10	14
Iron	µg/L	2,030	1	51
Lead	µg/L	146	54	10
Silicon	µg/L	1,380,000	1,240,000	331

To supplement the work done by Siemens, and to determine if there was any physical presence of the gel-like materials (discussed in Section 6.2.1) in the $FeCl_3$-generated precipitate, Key Environmental conducted a qualitative test to investigate. This test did not yield a gelatinous type precipitate as previously described, but rather produced a layer of very fine particles which were still in need of conditioning (i.e., polymer addition) to create a reasonably settled mass.

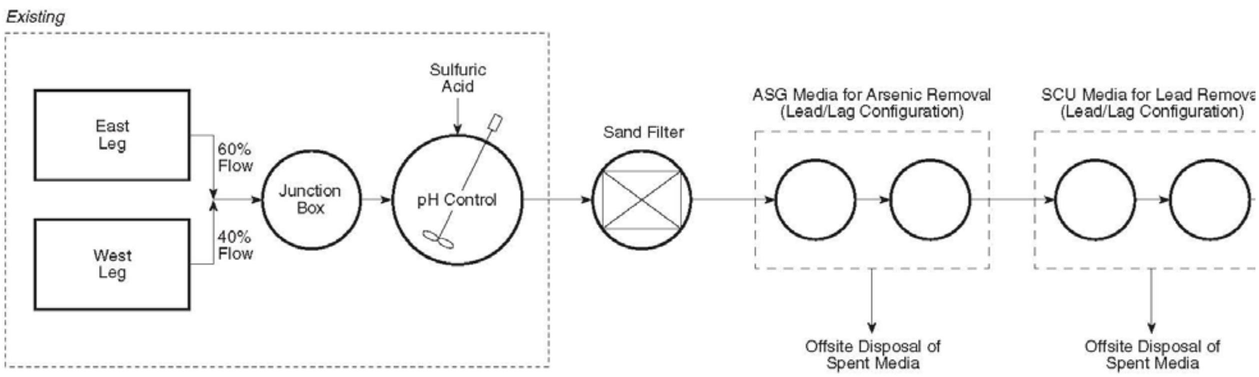
As discussed in Section 7.4, more representative and discerning treatability studies were conducted in 2014 which highlight the difficulties associated with replicating the results of these initial tests and the practical issues associated with addressing the intercepted leachate. (Revised January 30, 2015)

7.3 Technical/Economic Feasibility

7.3.1 Adsorption Technologies

Based principally on the column tests, it is generally evident that declines in media performance (observed after only 80 to 120 BVs) will be a significant impediment to employing this type of technology to the SLA seep water. In conventional drinking water applications for treatment of arsenic, it is typical for media life to be measured on the scale of thousands of BVs. Although not quantified by the column tests, the initial bench tests indicate that approximately 50 percent of the silicon is being retained on the media and is likely diminishing the available adsorptive capacity.

If such a system were considered for the SLA, it is envisioned that the simplistic conceptual process layout shown below would represent a starting point for additional metals treatment. As shown in the diagram below, the process would utilize the existing IAS to provide pH adjustment of the SLA seep water (pH target in the range of 7 to 8), then to be followed by routing through a back-washable sand filter to remove suspended solids prior to entering the media beds. The beds would provide for sequential treatment using ASG media for arsenic removal and SCU media for lead removal, and would allow for continuous operation when bed replacement is required. Neither the ASG nor the SCU media can be regenerated and would need to be disposed at an approved off-site facility.

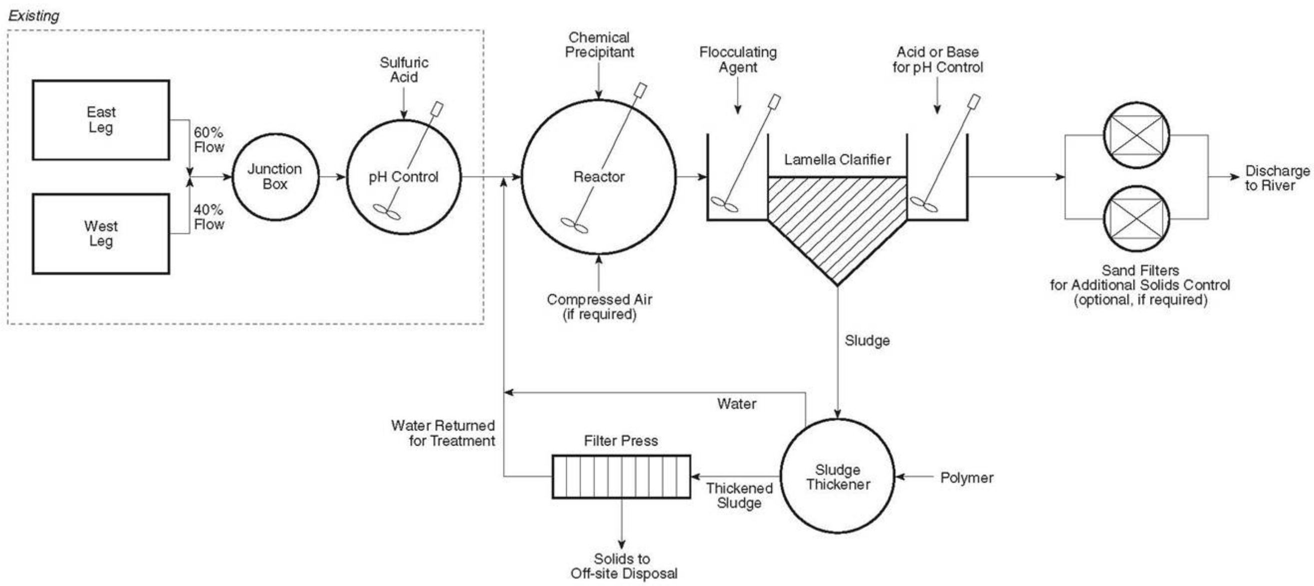


From a monetary perspective, the capital and operating costs presented herein are predicated on installation of a media-based system with capacity to treat a nominal 50 gpm flow. Accordingly, the estimated capital cost (consisting only of the components downstream of the collection and neutralization system) is at least $450,000 including design, installation, and startup. If 120 BV is used as the estimated trigger for media replacement (based on the column test results), this translates into nearly 1,000 bed change-outs over the course of a year (based on 50 gpm flow and a BV of 450 gallons). In turn, this corresponds to an annual media replacement cost (not including disposal) of approximately $17,600,000, which puts implementation of this technology well beyond the realm of technological and economic feasibility.

Comment No. 4 in the Department's May 13, 2014 Comment Letter indicated that PPG could have performed adsorption technology studies with pretreatment of the silicon, thus enabling high efficiency of certain metals removal. PPG addressed this issue in its June 25, 2014 Response Letter (Appendix Z). The extent to which there is a need for treatment beyond that which is currently provided in the IAS will be further evaluated in the NPDES permitting process. (Revised January 30, 2015)

7.3.2 Precipitation Technologies (Initial Assessment)

~~To this point,~~ **As of December 2012,** evaluation of precipitation-based technologies has been limited to very qualitative bench-scale tests, which indicated ferric chloride to be generally effective in achieving some measurable reductions in metals concentrations. If a precipitation technology were be considered for treating the SLA seep waters, more laboratory testing would be warranted to refine sludge generation rates and management requirements, chemical usage, and necessary unit operations. However, to visualize what such a system may entail, the conceptual process layout below is deemed representative of a starting point. **(Revised January 30, 2015)**



In similar fashion to that described above, the precipitation process would also utilize the existing collection and neutralization system to provide initial pH adjustment of the SLA seep water (to a target pH of 8) prior to dosing with ferric chloride (or another suitable reagent) in a flash mix tank. The resultant precipitate would then be removed in a lamella clarifier and the supernatant subjected to final pH adjustment (if needed) before passing through sand filters for removal of any residual suspended solids. Treated water would then be discharged to the Allegheny River. The sludge from the bottom of the lamella clarifier would be pumped to a sludge thickener, dosed with a polymer, and dewatered using a filter press. The dewatered sludge would be disposed at an approved off-site facility.

Assuming that typical reagent dosage and sludge generation rates would apply, and assuming that precipitation is deemed effective, preliminary capital and operation and maintenance costs may be estimated. Accordingly, for a system with a nominal 50 gpm processing capacity, the capital costs (consisting only of the components downstream of the collection and neutralization system) are estimated to range from approximately $750,000 to $2,250,000 including design, installation, and startup. Annual operating and maintenance costs are estimated to be in the range of $175,000 to $375,000 per year, including projected expenditures for sludge disposal. It is emphasized that these order-of-magnitude cost estimates are considered budgetary at best. The estimates are predicated on the, as yet, untested assumptions that successful application of the **well-established** conceptual precipitation process described above may be feasible and may afford a meaningful level of metals reduction. **(Revised January 30, 2015)**

7.4 Supplemental Precipitation Technologies Treatability Testing

An important component of evaluating the viability of installing internal interceptor trenches was determining the chemistry of the leachate that would be collected in this system from a treatability perspective. As discussed in Section 3.7, it is evident that the chemical characteristics of the leachate (dissolved metals and silica) differed from those of the seep water previously tested. In general, the leachate water proved to have lower metals concentrations but higher silica concentrations as compared to the seep water metals and silica concentrations. (Revised January 30, 2015)

Consistent with Comment No. 1 in the Department's May 13, 2014 Comment Letter, ARCADIS performed supplemental bench-scale treatability tests between February and November 2014 for leachate collected from the SLA as compared to seep water currently being collected by the IAS. The supplemental treatability tests were performed in a progressive manner, with findings from each phase being used to define the scope of the next phase. To support the remedial alternative discussions in Section 8.0 of this Report, PPG commissioned a treatability testing program to determine the efficacy of providing a reasonable reduction in the concentrations of the metals of interest within the realms of technical and economic feasibility. The following sections present the leachate sample collection and preparation rationale, testing objectives, bench-scale test setup, and results for each phase of the supplemental treatability tests. A detailed treatability testing technical memorandum is presented in Appendix V and a summary of the objectives and conclusions of each phase is presented below. (Revised January 30, 2015)

7.4.1 Phase I Treatability Testing Objectives and Sample Collection and Preparation

Based on an evaluation of the results for selected specific tests from the CB&I 2012 Treatability Study, the purpose of the 2014 Phase I supplemental treatability testing was to expand on the precipitation technologies portion of that testing. The Phase I treatability testing was performed from the perspective that leachate within the SLA would be collected for treatment in internal interceptor trenches before being expressed at the seep locations. In February 2014, leachate was collected from six piezometers closest to the proposed interceptor trenches to represent water for testing judged to be representative of conditions for leachate that would be intercepted. Details of the locations, rationale for selection, and decisions made to composite samples for the Phase I treatability testing program are presented in Appendix V. (Revised January 30, 2015)

In March and April 2014, the ARCADIS Treatability Laboratory in Raleigh, North Carolina, performed the Phase I precipitation technologies treatability testing to evaluate the following:

- **Neutralizing leachate pH following amendment with reagents to co-precipitate and coagulate the target metals aluminum, antimony, arsenic, chromium, iron, lead and silica**
- **The addition of two specific polymers to enhance particle flocculation and settling of precipitates**

(Revised January 30, 2015)

7.4.2 Phase I Treatability Testing Conclusions

Results of Phase I treatability testing are presented in Appendix R and are also included in Appendix V. The pH adjustment, co-precipitation, and coagulation step resulted in an increase in the dissolved metal concentrations for all the amendments evaluated, as compared to the untreated 50:50 groundwater composite baseline sample (Table 3 in Appendix V). All the amendment samples indicate a decrease in dissolved silica concentrations. The absence of visual indications of precipitate formation and the corresponding increase in dissolved metals concentrations following coagulant amendment and pH adjustment indicated the potential for soluble complex formation or complexes formed with submicron colloidal matter in the leachate during the treatment process. For example, dissolved iron increased with the addition of ferric chloride. Also, the low levels of arsenic and chromium can be present in commercial reagents such as ferric chloride and magnesium chloride. The heterogeneity in leachate quality indicated the potential for interference in the removal of metals using precipitation, coagulant, and polymer chemistry. (Revised January 30, 2015)

For the polymer addition step, compared to the pH adjustment and co-precipitation/ coagulation step, the concentration of dissolved metals (specifically antimony, arsenic, and lead) decreased following addition of two polymers with one polymer (Nalco) performing marginally better than the other (GE Betz), as shown on Table 4 in Appendix V. Aluminum and iron increased in concentration from the baseline sample, possibly due to the aforementioned complexation. The increasing concentrations during amendment addition may be attributed to the potential for soluble complex formation or complexes that form with submicron colloidal matter (i.e., silicates) in the leachate during the treatment. Similar to the previous step, the polymer addition also showed decreased silica concentrations with the Nalco polymer showing the most significant reduction (4,700 mg/L to 220 mg/L). (Revised January 30, 2015)

7.4.3 Phase II Treatability Testing Objectives

Based on findings from the Phase I treatability testing and following review of available research literature, additional treatability testing was recommended. Given the differences in chemical composition between historic seep water results and the Phase I composite samples, 10 individual piezometers were sampled in May 2014 to establish a better leachate baseline in the SLA. Those results are discussed in Sections 3.7 and 5.1.1.

Based on the May 2014 piezometer sample results and the effects of silica on the Phase I treatability testing, leachate from five piezometers having the highest silica concentrations were composited (Composite A). Leachate from three piezometers having lower silica concentrations were composited (Composite B). Separate testing on each composite was completed. Two of the piezometers sampled in May 2014 had extremely low silica and were excluded from consideration for testing. Details of the locations, rationale for selection, and decisions made to composite samples for the Phase II treatability testing program are presented in Appendix V.

The Phase II treatability testing was scoped to evaluate the effects of gradual pH adjustment to slow down silica precipitation kinetics and determine whether a crystalline precipitate could be formed, rather than an amorphous gel (as described in Section 7.4.4). In addition to gradual pH adjustment, ferric chloride was added to facilitate metals removal through co-precipitation. The Phase II treatability testing was performed in the ARCADIS Treatability Laboratory in July and August 2014 to evaluate the following:

- **Stepwise pH neutralization of groundwater over an extended duration (4 hours) and the rate of pH variation on precipitate formation and quality**
- **Stepwise pH neutralization coupled with coagulant ferric chloride over an extended duration (4 hours) and evaluate effect of residence time on precipitate formation and quality**

(Revised January 30, 2015)

7.4.4 Phase II Treatability Testing Conclusions

The combined effect of pH and coagulant chemistry on silica precipitation was evaluated during the Phase II Treatability Testing. Removal of dissolved metal species was achieved in Phase II using pH adjustment, precipitation, and coagulation. However, during the pH adjustment step alone, no significant reduction in aluminum, antimony, arsenic, chromium, and lead concentrations was achieved, as shown on Table 7 in Appendix V. Adjustment of pH alone also did not reduce dissolved silica concentrations. During the pH adjustment, precipitation, and coagulation step, the removal of metals occurred along with the removal of dissolved silica from solution. However, the applicability of the chemistry and process to

the design of a full-scale treatment system was considered impracticable and economically infeasible due to the challenges associated with handling large volumes of amorphous silica gel produced as a treatment residual. (Revised January 30, 2015)

As further described in Appendix V, the results of the Phase II Treatability Testing indicated a high degree of polysilicate formation. Polysilicates are not uniformly sized and cannot be arranged in a crystalline lattice. As a result, polysilicates will form voluminous amorphous gel precipitates rather than crystalline precipitates (crystalline precipitates settle and dewater readily). To yield crystalline precipitates, polysilicate ions must be depolymerized to smaller silicate ions to facilitate arrangement into a regular crystal lattice, which can be managed as precipitated solids as opposed to an amorphous gel precipitates, which are considerably more difficult to manage. Phase III Treatability Testing was initiated to further evaluate depolymerization of amorphous gel precipitates. (Revised January 30, 2015)

7.4.5 Phase III Treatability Testing Objectives

Prior to initiation of Phase III Treatability Testing in October 2014, the same source water comprising Composite A and Composite B and a new Composite C (consisting of 50 percent Composite A and 50 percent Composite B) were collected. During Phase III, testing was done on Composites A, B, and C to evaluate treatability across the spectrum of leachate quality. Details of the locations, rationale, and decisions made to composite samples for the Phase III treatability testing program are presented in Appendix V.

The Phase III Treatability Testing was also conducted by the ARCADIS Treatability Laboratory in October and November 2014 to evaluate the following:

- **Testing three different amendments of sodium chloride, magnesium chloride, and calcium chloride to evaluate removal of metals with a secondary goal of minimizing gel formation.**
- **Neutralizing leachate pH during amendment addition while minimizing gel formation.**
- **Evaluation of interaction of dissolved silica concentrations with amendment addition and its effect on precipitate form, quality and quantity.**

(Revised January 30, 2015)

7.4.6 Phase III Treatability Testing Conclusions

Phase III treatability testing was designed partly based on findings from Phase I and Phase II treatability testing and partly on research literature demonstrating the

relationship of alkali and alkali earth metal salts such as sodium, magnesium, and calcium as chloride complexes affecting dissolution of silica. (Revised January 30, 2015)

As further described in Appendix V, results of Phase III Treatability Testing using sodium chloride indicated removal of aluminum, iron, and lead. In comparison, only marginal removal was achieved for antimony and chromium. Increased arsenic concentrations may be attributed to possible chelated complexes forming in solution. Marginally greater effectiveness was achieved with the higher dosage rate concentration of sodium chloride amended to the leachate; however, compared to the concentrations of these metals in the untreated leachate, the removal was insignificant. Addition of ferric chloride to the reactors after amendment with sodium chloride resulted in filtration challenges indicating the formation of suspended colloidal precipitates or a pre-cursor to the amorphous gel precipitate observed in Phase I and Phase II Treatability Testing. (Revised January 30, 2015)

As further described and summarized in Table 10 of Appendix V, results of Phase III Treatability Testing described above using magnesium chloride indicated removal of aluminum, iron, and lead. In comparison, only marginal removal was achieved for antimony and chromium. Arsenic concentrations were observed to increase and may be attributed to possible chelated complexes forming in solution, similar to the chelated complexes that formed with the sodium chloride amendment. Addition of magnesium chloride decreased the pH of the leachate significantly thereby reducing the quantity of sulfuric acid needed to meet the target pH of 8.0. Contrary to the tests using sodium chloride, the addition of ferric chloride to the reactors after amendment with magnesium chloride resulted in the settling of a crystalline precipitate formed after the addition of the magnesium chloride. This well settled crystalline precipitate was easily filtered and was more suitable when compared to the sodium chloride tests. (Revised January 30, 2015)

As further described in and summarized in Table 10 of Appendix V, results of Phase III Treatability Testing using calcium chloride indicated removal of aluminum, chromium, iron, and lead. In comparison, only marginal removal was achieved for antimony. Arsenic concentrations were observed to increase and may be attributed to possible chelated complexes forming in solution, and the fact that it is detected in the calcium chloride reagent. Addition of calcium chloride decreased the pH of the groundwater, thereby reducing the quantity of sulfuric acid needed to meet the target pH of 8.0. Contrary to the sodium chloride tests, the addition of ferric chloride to the reactors after amendment with calcium chloride resulted in formation of a well settled crystalline precipitate which was easily filtered and was more suitable when compared to the sodium chloride tests. Magnesium chloride and calcium chloride exhibited similar metals and silica reductions (Table 10 in Appendix V). (Revised January 30, 2015)

7.4.7 Supplemental Precipitation Technologies-Technical/Economic Feasibility

The results obtained from the three phases of supplemental bench-scale treatability testing completed in 2014 provide additional insight regarding overall water chemistry at the site. (Revised January 30, 2015)

During Phase I Treatability Testing, observations related to pH adjustment, silica concentrations, and the heterogeneity in leachate quality indicated the potential for interference in the removal of low parts-per-billion concentrations of metals using conventional precipitation, coagulant, and polymer chemistry. The apparent presence of these interfering agents indicated the necessity of pretreatment prior to applying a selected water chemistry approach. Results obtained from Phase I showed potential for the formation of metal complexes with silicates inhibiting their targeted removal (i.e., treatment of metals without removal of silica), and consequently, treatment efficiency. (Revised January 30, 2015)

Phase II Treatability Testing provided further insight into the combined effect of pH adjustment and precipitation/coagulant chemistry on the leachate constituents, in particular, on silica precipitation. Removal of dissolved metal species and silica from solution was achieved to a significant extent in Phase II Treatability Testing using pH adjustment, precipitation, and coagulation. However, the applicability of the chemistry and process to the design of a full-scale treatment system was considered impracticable or economically infeasible due to the large volume of amorphous silica gel produced as a treatment residual (up to 90 percent of the leachate volume was taken up by the gel). (Revised January 30, 2015)

Phase III Treatability Testing was designed to demonstrate the relationship of alkali and alkali earth metal salts affecting dissolution of silica. Results from Phase III Treatability Testing indicated metals and silica removal using sodium chloride with marginally better effectiveness using magnesium chloride and calcium chloride. However, the quantity and type of precipitate formed was more suitable in the magnesium chloride and calcium chloride tests when compared to the sodium chloride tests. To evaluate effectiveness, the quantity of salts amended to the volume of leachate during the magnesium and calcium chloride tests were likely conservative and, therefore, would require optimization if applied to a full-scale system. Therefore, additional testing of amendment dosage and quantity of precipitate formed is ongoing, and further evaluation may be necessary in the context of the NPDES permitting process, if such treatment is warranted. (Revised January 30, 2015)

Phase IV Treatability Testing has been initiated to test the efficacy of lower doses of magnesium chloride and calcium chloride as primary amendments to a co-precipitation-based treatment system. (Revised January 30, 2015)

Based on reasonably conservative amendment dosages predicted by Phase III Treatability Testing findings and corresponding sludge generation rates, preliminary capital and operation and maintenance costs may be estimated. Accordingly, for a system with a nominal 80 gpm processing capacity, the capital costs (consisting only of the components downstream of the collection system) are estimated to range from approximately $2,100,000 to $3,000,000 including design, installation, and startup (excludes groundwater collection and conveyance). Annual operating and maintenance costs are estimated to be in the range of $700,000 to $1,200,000 per year, including projected expenditures for sludge disposal. It is emphasized that these reasonable order-of-magnitude cost estimates are considered budgetary at best. Further, while Phase III Treatability Testing indicated removal of potential metals of interest on a percentage basis, given the low mass of these metals in the untreated leachate in absolute terms, the benefit of such removal is questionable. (Revised January 30, 2015)

7.5 Summary

As represented by the information presented in Section 7.1, the SLA activities are not directly associated with industrial categories for which published technology-based ELGs exist. The most comparative and logical form of technology-based effluent limitations emerged from the USEPA-developed RGP as discussed in Section 7.1.2. Technologies evaluated as part of the treatability testing efforts have led to the conclusion that the SLA seep water matrix is not amenable to treatment via adsorptive media (for both technical and economic reasons). Precipitation may hold merit but would require ~~significant~~ further refinement to identify and evaluate precipitation methods that may be applied to the seep water and **leachate** to move past assumptions and professional judgment **and to develop more refined capital and operating costs**. The current treatment afforded by the IAS**, which would be replicated by a permanent neutralization-only treatment system, would result** ~~results~~ in a discharge that is fully protective of water quality and contains metals at concentrations that already meet comparable federal ELGs as used in the context of the RPG-prescribed remediation discharge standards. **The extent to which there is a need for treatment beyond that which is currently provided in the IAS will be further evaluated in the NPDES permitting process. (Revised January 30, 2015)**

8.0 Evaluation of Remedial Alternatives

Potential remedial alternatives for long-term management of the source material and water discharging from the former slurry lagoons to meet the defined RAOs as presented in the approved Treatment Plan are evaluated in this section.

8.1 Remedial Action Objectives and Evaluation Criteria

RAOs and the evaluation criteria used to assess the remedial alternatives are discussed in this section. RAOs are identified in Section 8.1.1. Evaluation criteria are discussed in Section 8.1.2.

8.1.1 Remedial Action Objectives

RAOs have been identified that are protective of human health and ecological receptors and are consistent with the requirements of the AO and the Treatment Plan. The following RAOs are either explicitly prescribed in the Performance Objectives listed in the AO or are implied through required analyses and evaluations:

- Collect and convey industrial waste discharges, leachate, and seeps to an industrial waste treatment facility. Discharge of the treated water to waters of the Commonwealth is currently authorized pursuant to the Department's July 2, 2009 letter approving the IAP; however, upon approval of this Report and implementation of the recommended remedial alternative, discharge will be authorized under an NPDES permit.
- Provide security that will exclude unauthorized access to areas of the SLA and unauthorized persons contacting the leachate and seeps.
- Ensure the stability of the slopes above Glade Run and the Allegheny River.

Of the three above-listed RAOs, additional security was provided at the SLA within 30 days of issuance of the AO when warning signs were posted and additional fencing and lockable gates were installed to exclude unauthorized access to the SLA. The stability of the slopes above Glade Run and the Allegheny River was evaluated through the drilling of geotechnical test borings, geotechnical analysis of soil samples, and performance of a slope stability and is discussed in Section 4.0 of this Report. The further collection and treatment of industrial waste discharges, leachate, and seeps, is addressed in this section of the Report via evaluation of various remedial alternatives. Other RAOs were identified by Baker Environmental in the 1995 "Feasibility Study for the Ford City Site" that addressed site security and protection of human health limiting the potential for ingestion of and dermal contact with sediments and water from the SLA. These identified RAOs have largely been addressed through the installation of fencing, by placing cover soil on the upper surface of the SLA, and by posting warning signs. Potential human health and ecological risks were further addressed through implementation of the IAP under the AO.

Comment No. 23 in the Department's May 13, 2014 Comment Letter addressed the above-described RAOs, and Comment No. 25 in the Department's Comment Letter indicated that PPG should evaluate remedial alternatives against the RAOs. PPG provided its responses to Comments Nos. 23 and 25 in the June 25, 2014 Response Letter and has revised this section consistent with that response and follow-up discussions with the Department. (Revised January 30, 2015)

8.1.2 Remedial Alternative Evaluation Criteria

As required by the Department-approved Treatment Plan dated June 8, 2009, identified remedial alternatives were evaluated based on the criteria contained in Section 304(j) of Pennsylvania Act 2. The following Act 2 Section 304(j) criteria were considered in evaluating the identified remedial alternatives and were used to rank the remedial alternatives on a relative basis:

- Long-term risks and effectiveness of the remedial alternatives
- Reduction of toxicity, mobility, or volume of regulated substances
- Short-term risks and effectiveness of the remedial alternatives
- The ease or difficulty of implementing the remedial alternatives
- The cost of the remedial alternatives
- The incremental health and economic benefits compared to the incremental health and economic costs associated with implementing the remedial alternatives

8.2 Previously Identified and Evaluated Remedial Alternatives

Remedial alternatives for the SLA have been evaluated in previous studies of the SLA. Various remedial alternatives were identified and evaluated by D'Appolonia (1971), Baker Environmental (1995), and Key Environmental (2000). D'Appolonia's recommended approach to mitigating seepage was based primarily on technical feasibility whereas the remedial alternatives evaluated by Baker Environmental and Key Environmental focused primarily on mitigating potential human health and ecological risks and/or mitigating leachate generation and seepage.

The following remedial alternatives were considered by D'Appolonia:

- Collect and treat outflow from the former slurry lagoons
- Grade the surface of the SLA to prevent ponding and insure rapid runoff
- Seal the lagoons to prevent leakage
- Seal the lagoons to prevent inflow
- Remove the waste material
- A combination of the above-listed remedial alternatives

D'Appolonia concluded that the two sealing options were not justified because of the uncertainties of estimating groundwater flow paths and quantities and the effectiveness of the sealing alternatives. D'Appolonia's report recommended that remedial alternatives should focus on controlling surface water run-on and runoff and grading the upper surface of the SLA for runoff control. Following the issuance of the D'Appolonia report, soil was applied to the upper surface of the SLA to assist in establishing a vegetative cover and to prevent direct dermal contact with and possible ingestion of the source material and to mitigate any surface water coming into contact with the source material.

Baker Environmental identified and evaluated a variety of remedial alternatives, including containment of the source material through capping; excavation of the source material and disposal at an off-site facility; in situ and ex-situ treatment of the source material; collection and diversion of water through surface controls such as channels, culverts, and berms; and collecting and managing groundwater within the source material through horizontal and vertical wells. After considering the effectiveness, implementability, and relative costs of identified remedial alternatives, Baker Environmental concluded that the remedial alternatives listed below were most suited to the conditions at the SLA and that they were protective of human health and ecological receptors. The remedial alternatives evaluated by Baker Environmental in its 1995 feasibility study are as follows:

- No action
- Limited action
- Constructed wetlands/habitat enhancement
- Containment (capping)
- Treatment (in situ stabilization)

Baker Environmental concluded that the surface soils in the SLA posed no unacceptable risk to human health from direct contact and there risk associated with ingestion of and direct contact with surface water and sediments containing arsenic above background concentrations was within the acceptable range given site-specific conditions. Based on a conservative screening level assessment, Baker Environmental concluded that lead concentrations in surface soils could posed a potential risk to terrestrial organisms (primarily earthworms), and that lead concentrations in surface water and sediments could pose a potential risk to aquatic or benthic organisms. As indicated, a qualitative assessment versus screening levels was performed but a quantitative evaluation of such risks was not completed. Baker Environmental also concluded that existing wetlands in the area surrounding the SLA may act as natural treatment systems to minimize potential impacts for ecological receptors. Evaluation of the Baker Environmental risk assessment confirmed that it remains valid for current conditions existing at the SLA with respect to human health and ~~that current conditions do~~ **will** not pose an unacceptable risk to ecological receptors. **(Revised January 30, 2015)**

The feasibility study prepared by Baker Environmental concluded that the constructed wetlands and habitat enhancement remedial alternative would be cost effective and protective of human health and ecological receptors. As described above, the site is currently well vegetated, includes several defined wetlands, and is inhabited by a variety of wildlife. Although Baker Environmental concluded that constructed wetlands could achieve RAOs, it did not recommend implementing this remedial alternative because existing natural wetland areas in the vicinity of the SLA provided natural treatment mechanisms that would result in partial reduction of constituent levels in seeps and surface water runoff. The Baker Environmental report also contained several recommendations to address the identified potential risks. These recommendations were implemented subsequent to issuance of the report and included placing development restrictions in the deed to the property, installing fencing to restrict access to the site, and placing cover soil over barren areas on the upper surface of the SLA.

Key Environmental focused on reducing infiltration to minimize leachate generation and concluded that the remedial alternatives should address identified constituents of interest and migration pathways. Three alternatives to accomplish these objectives were presented in Key Environmental's Investigation Report, dated July 2001, as follows:

- Enhanced surface water runoff from the top of the SLA through the construction of a system of storm water management channels
- Enhanced evapotranspiration from the top of the SLA through the planting of phreatophytes
- Restoration of vegetation with high pH-tolerant species in denuded areas

Comment No. 24 in the Department's May 13, 2014 Comment Letter included descriptions and dispositions of the above-described previously identified and evaluated remedial alternatives. These issues were addressed in PPG's June 25, 2014 Response Letter and follow-up discussions with the Department. (Revised January 30, 2015)

8.3 Identification and Evaluation of Remedial Alternatives

In developing remedial alternatives for the SLA, consideration was given to existing site conditions, activities that have been previously implemented to address previously developed RAOs, and actions that have been taken during implementation of the IAP. The existing condition of the SLA was described in Section 1.2 of this Report and as noted in that description, the upper surface and outside of the dikes are well vegetated with grass, brush, and some trees. Previously, fencing was installed and topsoil was placed to establish vegetative cover and isolate the source material to minimize potential for ingestion and dermal contact. With implementation of the IAP, some small areas previously devoid of vegetation have been revegetated, mulch beds have been installed to neutralize seepage in more remote areas of the SLA, and actions have been taken to collect and treat the seeps. These actions have resulted in further minimization of potential risks to human health and ecological receptors as well as an overall improvement in the appearance of the SLA.

The proposed remedial alternatives address the RAOs listed in Section 8.1 of this Report in that they are intended to eliminate seepage from the SLA or otherwise continue to collect and treat the seepage. The proposed remedial alternatives are evaluated based on the criteria listed in Section 304(j) of Act 2 as a means of determining attainment of Act 2 standards and to assist in selection of the most suitable remedial alternative. Previously implemented remedial actions would rank comparatively well under the criteria of Section 304(j) of Act 2 in that they have reduced or eliminated long-term risks; reduced toxicity, mobility, or volume of regulated substances; and addressed short-term risks. The relative evaluations of remedial alternatives presented in this Report consider the ease or difficulty of implementation, cost, and incremental health and economic benefits compared to the incremental health and economic benefits associated with implementing the remedial alternatives. The following remedial alternatives are based on existing conditions in the SLA and previously implemented remedial actions:

- No Further Action – Involves taking no further actions to mitigate potential human health and ecological risks and includes discontinuing operation of the existing IAS.

- Continued Collection and Treatment – Involves continued operation of the IAS as it is currently being operated and maintained.

- Enhanced Collection and Treatment – Involves enhancing the existing IAS collection system by collecting additional seeps, collecting shallow groundwater on the eastern end of the South Bench, segregating unimpacted storm water, ~~and providing for improved maintenance of mulch beds~~ **reducing infiltration, and collecting or eliminating the seeps on the Western Slope.** Enhanced treatment considers three sub-alternatives, including providing additional capacity to treat increased flows, as is currently occurring with the IAS; precipitation technology; and conveying the water to a Publicly Owned Treatment Works (POTW). **Supplemental investigative activities were performed by ARCADIS to refine the conceptual site model and to further evaluate the Enhanced Collection and Treatment remedial alternative recommended in the December 2012 edition of this Report. ARCADIS evaluated Enhanced Collection and Treatment using interceptor trenches completed internal to the SLA along the southern and eastern boundaries of the SLA (the proposed trench locations are presented on Figure 1 of Appendix W). Installation of interceptor trenches would serve to segregate unimpacted storm water while eliminating seeps by dewatering of the leachate within the SLA. Additionally, ARCADIS is evaluating revegetating remaining areas barren of vegetation and installation of shallow drains at selected locations on top of the SLA to further reduce infiltration. ARCADIS is also evaluating methods to intercept leachate on the western side of the SLA to eliminate the seeps currently being expressed on the Western Slope. (Revised January 30, 2015)**

- Infiltration control through regrading, capping, or phytoremediation by implementing measures to contain the source material with the goal of eliminating the seeps that are currently being collected and treated in the IAS.

All remedial alternatives with the exception of No-Further Action would include updated deed restrictions and covenants consistent with Pennsylvania Act 68 precluding or restricting access, residential and recreational use, as appropriate, to eliminate any unacceptable risks to human health. In addition, and to the extent relevant to such remedial alternatives, financial assurance for future operation and maintenance will be an appropriate topic for discussion with the Department. (Revised January 30, 2015)

Other remedial alternatives considered in this Report include but are not limited to: internal leachate collection **using extraction wells**, beneficial reuse, in situ treatment of the leachate and/or source material, passive treatment in constructed wetlands, ex-situ treatment of the source material, and excavation and disposal of the source material at a permitted waste disposal facility. Baker Environmental evaluated some of these alternatives and eliminated them from further consideration because implementability and relative cost compared to other remedial alternatives did not make them viable compared to other remedial alternatives; however, they are re-evaluated in this Report in light of remedial actions that were previously implemented at the SLA and with respect to the Act 2 Section 304(j) criteria. **(Revised January 30, 2015)**

Each of the above-listed remedial alternatives is discussed in greater detail in the following sections; however, it should be noted that remediation is currently occurring at the site in accordance with the requirements of the AO. This remediation includes updated access controls in relevant site areas, active and passive treatment of the seeps, and revegetation of areas devoid of vegetation to assist in reducing infiltration and seepage from the SLA.

8.3.1 No Further Action

No Further Action is a baseline alternative based on the assumption that no additional work has been completed at the SLA subsequent to issuance of the AO. This remedial alternative involves leaving the source material in place; continuing to restrict access to the areas where seeps occur on the South Bench, Western Slope, and in the Drainage Ditch; and discontinuing operation of the collection and treatment system implemented under the IAS.

The No Further Action alternative assumes no change to the current use of the property, which is non-residential and assumes discontinued operation of the collection and treatment system because no significant human health and ecological risks exist. Under this remedial alternative, the existing treatment system would be decommissioned by removing all material and equipment, including any residual sulfuric acid remaining in the storage tank, the control building, junction box, and mix tank and mixer and either recycling or disposing these materials.

The weir bypass structure would also be removed and pipe that conveys water to the junction box would be capped. The channel at the weir bypass structure would be reestablished to convey runoff as it did prior to installation of the weir bypass structure. The collection channel on the western part of the South Bench would be reclaimed and the area would be regraded for positive flow of surface water runoff. The pipe at the downstream end of the collection channel also would be capped. The existing environmental restrictive covenants would be retained.

The No Further Action remedial alternative would be readily implementable and would involve only limited demolition and decommissioning activities because the existing seepage would not be further addressed. The estimated cost of this remedial alternative is $100,000, most of which would be for decommissioning the collection and treatment system and disposal.

8.3.2 Continued Collection and Treatment

The Continued Collection and Treatment remedial alternative involves leaving the source material in place; restricting access to the areas where seeps occur on the South Bench, Western Slope, and in the Drainage Ditch; and continuing operation of the IAS. This remedial alternative also assumes no changes to the current use of the property, which is non-residential. The Continued Collection and Treatment remedial alternative would also include updating the existing deed restrictions by executing environmental covenants in accordance with Pennsylvania Act 68. The cost associated with executing an environmental covenant would essentially involve legal and administrative fees, which are estimated to be in the range of $20,000 to $30,000.

With respect to the criteria listed in Act 2 Section 304(j), this remedial alternative has essentially already been implemented and it addresses the RAOs. By continuing to collect and treat seepage from the SLA, this remedial alternative has substantial incremental health and economic benefits and an incremental cost that consists of the annual operation and maintenance cost, which is estimated to be approximately $100,000. This annual cost consists of operating and maintaining the collection and treatment system, monitoring, and maintaining the access roads and access control. Monitoring would consist of routine inspections of the site, collecting samples for analysis as required by permit, and preparing and submitting monitoring reports to the Department.

8.3.3 Enhanced Collection and Treatment

The Enhanced Collection and Treatment remedial alternative is a substantial expansion and improvement of the Continued Collection and Treatment remedial alternative in which the additional flows from as of yet uncollected seeps will be collected for treatment. Section 8.3.3.1 of this Report addresses enhancements to the seep collection system and other general site improvements. Sections 8.3.3.2, 8.3.3.3, and 8.3.3.4 address three sub-alternatives for treating the water and other proposed general site improvements.

8.3.3.1 Collection System Upgrades and General Site Improvements

While the AO requires the collection and treatment of all named seeps, additional unnamed seeps have been identified at the site. Five of these additional unnamed seeps have already been captured as a result of continuing improvements to the IAS. The existing treatment system has been used to manage all collected seepage to date **and would continue to be utilized as necessary while the Enhanced Collection and Treatment remedial alternative is implemented (anticipated to be no more than two years)**. Enhanced collection would consist of ~~four~~ **the following** primary components**:**~~, as follows:~~

- ~~The collection of additional seepage which has not been captured to date~~
- ~~Further segregation of unimpacted storm water~~
- ~~Improvements to the passive treatment mulch beds at the bottom of the Western Slope~~
- **Installation of internal interceptor drains on the eastern and southern sides of the SLA to collect leachate and convey it for treatment and discharge under a NPDES permit**
- **Intercepting the seeps on the Western Slope through installation of angled wells or collecting the seeps at their existing locations and conveying the water for treatment**
- **Installation of shallow drains at selected locations on top of the SLA, revegetation of remaining areas barren of vegetation on top of the SLA, and planting of selected vegetation to reduce infiltration**

Each of these enhanced collection system components and general site improvements is discussed in the remainder of this subsection. The conceptual approach to this remedial alternative ~~is~~ presented below **represents an Enhanced Collection and Treatment approach that was developed as an outcome of the additional evaluations that were performed by ARCADIS in 2014. This approach is consistent with the Enhanced Collection and Treatment remedial alternative described in the December 2012 Report in that it will achieve the intended purpose of collecting and treating leachate from within the SLA but in a more effective manner.**~~ as is some initial design information.~~ Thes~~e~~ collection system upgrades and general site improvement elements of the Enhanced Collection and Treatment remedial alternative **presented in the December 2012 Report** ~~have been~~ **included an existing conditions survey of the area along the railroad tracks and the culverts in that area.** Figure 1 in Appendix M**, which** is a plan that shows the existing collection system at the SLA, and Figure 2 **in Appendix M showing** the proposed upgrades **in the December 2012 Report** to enhance the collection and treatment system **provide this survey information**. **(Revised January 30, 2015)**

Collection of Additional Seepage

As indicated above, five additional unnamed seeps have been captured during the course of operation, maintenance, and improvement of the existing IAS. In addition to these seeps, seepage also discharges over the sandy shale and shale outcrop adjacent to the Pittsburgh and Shawmut Railroad tracks, and this seepage has not been captured to date. **In 2014,** PPG ~~has already~~ initiated investigatory efforts to evaluate **other** methods by which this additional seepage can be captured**. As a result of these additional investigative activities, it became apparent that collection of leachate internal to the SLA (via use of an interceptor trench), as described in the next section, is the most effective method to eliminate the seeps. (Revised January 30, 2015)**

~~After negotiation of an access agreement with the railroad, a detailed topographic survey was completed along the railway to support this evaluation (Appendix M). In addition, preliminary flow measurements have been completed at various culverts along the railway to allow estimation of the baseline volume of additional seepage that would be captured. These preliminary flow measurements are summarized on the table in Appendix M.~~ **(Revised January 30, 2015)**

~~The results of the topographic survey indicate that construction of a collection system adjacent to the railroad tracks is technically feasible. Coordination issues may have to be resolved with the Pittsburgh and Shawmut Railroad if work must be performed on their property. Inspection of the location of various seeps along the railroad indicates that capture of seepage along an approximate 700-foot frontage would be necessary. Flow measurements at existing culverts along the railroad tracks indicate that collection of approximately 8 gpm would be sufficient to capture heretofore uncaptured seepage along the railroad. This estimated flow is based on measurements completed from April through October of 2012 (see Appendix M for a tabulation of the measured flows) and should be adequate for design purposes, with an appropriate margin of safety. Given the origin of this seepage, flows are not expected to vary significantly in response to seasonal or meteorological variability in the same manner as the seeps on and at the toe of the SLA berms. Flows from the existing culverts along the railroad tracks continue to be measured as part of weekly operation, maintenance, and monitoring activities and these data would be considered during the design phase for this alternative. Drainage channels or French drains are suitable means of collecting this seepage. The collected seepage would be conveyed by gravity to a lift station and would be pumped to the treatment system. The seepage would be pumped uphill to the South Bench (elevation change approximately 70 feet) with a minimum pipe length of approximately 200 feet.~~ **(Revised January 30, 2015)**

~~Drainage via existing culverts would be improved such that storm water runoff would be segregated from the baseline seep flow. The design of drainage improvements and the collection system would have to be reviewed and approved by the Pittsburgh and Shawmut Railroad.~~

~~Major design considerations for this component of the alternative include, but are not necessarily limited to, the following:~~

- ~~Invert elevations for the drainage channel or French drains~~
- ~~Channel dimensions or French drain pipe sizes and slopes~~
- ~~The dimensions and final location of the lift station~~
- ~~The elevation of the base of the lift station and the sump depth~~
- ~~Friction losses, elevation head calculations, and pump sizing~~
- ~~Conveyance piping materials, sizing, and supports~~
- ~~Process considerations consisting of level and flow control~~
- ~~Power and process control wiring considerations~~
- ~~Winterization considerations for the pump and piping~~
- ~~Access for cleanout of accumulated scale and sediments~~
- ~~Culvert improvements to accommodate storm water~~
- ~~Type and location of piping connections for the conveyance line~~

~~Considering that the water discharging over the shale and sandy shale outcrop has been demonstrated to exist as shallow groundwater in bedrock flowing beneath the eastern end of the South Bench, collection of this shallow groundwater may also be implemented as part of the collection system upgrades. If this groundwater is collected for treatment, it would involve installing additional shallow French drains that convey the groundwater by gravity flow to the treatment system at the approximate location shown on Figure 1 in Appendix M. An evaluation will be made as to the benefit of collecting this shallow water in bedrock versus simply allowing it to continue to discharge over the shale and sandy shale outcrop and collecting it in the above-described system along the railroad tracks.~~ **(Revised January 30, 2015)**

~~Design of the enhanced collection system would be completed based on existing data to the extent possible. Collection of additional information may be necessary to support the final design. In particular, input from the railroad will be required.~~ **(Revised January 30, 2015)**

Collection of Leachate Internal to SLA

Considering that the origins of the seeps are attributable to leachate accumulated within the SLA, this alternative focuses on relieving the SLA groundwater head in contact with the south and east berms/highwalls to prevent leachate-impacted seeps from occurring. This approach consists of the installation of subsurface interceptor trenches along the edges

of the south and east boundaries within the SLA to collect and convey leachate to a treatment system. Depending on the contour of the bedrock surface, the interceptor trench system would convey leachate by a combination of gravity and pumping to the pumping stations. The interceptor trench will serve as a dewatering system for the leachate within the SLA and, therefore, will reduce and, within a relatively short timeframe, eliminate the leachate that is being expressed in the seeps adjacent to the railroad tracks, on the South Bench, at Seep 105 on the eastern embankment, as well as the diffuse impacted discharge to the Drainage Ditch. This approach will prevent mixing of the leachate with storm water and will eliminate the potential for direct contact. The Conceptual Collection and Conveyance System Description, which was submitted to the Department on September 3, 2014, is contained in Appendix W. (Revised January 30, 2015)

As described in Appendix W, the proposed collection trench is likely to be installed using a continuous trenching system, known as a One-Pass Trenching System. The One-Pass trenching system is particularly applicable to the proposed Enhanced Collection and Treatment system sub-alternative because it allows for excavation of the source material and installation of pipe, aggregate, and trench backfill in one operation. The proposed collection trench would be comprised of perforated high-density polyethylene pipe of a specific diameter and perforation slot size to convey the design flow for the treatment system, a coarse aggregate envelope surrounding the perforated pipe, and backfill material above the coarse aggregate. (Revised January 30, 2015)

During construction of the interceptor trenches, the perforated pipe and coarse aggregate envelope will be installed at the bottom of a trench on bedrock along the south and east SLA perimeter along the approximate alignments shown on Figure 1 in Appendix W. The interceptor trench would convey leachate ideally by gravity flow from within the SLA to a series of sumps/pumping stations to be installed at specific intervals along the length of each trench depending on the contour of the bedrock encountered during installation. Following collection of leachate in the pumping stations, collected leachate will be conveyed in one or more force mains to a treatment system. (Revised January 30, 2015)

Design considerations for the interceptor trench system still to be evaluated include:

- **Sizing of interceptor trench, method of installation, material of construction, and suitable backfill and piping supports**
- **Dimensions of collection sumps/pumping stations and material of construction**
- **Dimensions and location of lift stations and materials of construction, pump sizing and hydraulic calculations**

- **Location of cleanouts for the interceptor trench (maintenance of scale build-up will be an operational expectation)**

- **Conveyance and connection to the wastewater treatment system**

Design of the interceptor trench system would be completed based on existing information, to the extent possible; however, additional information may be necessary to support the final design. Figures 1, 2, and 3 in Appendix W show the layout and potential configuration of the conceptual interceptor trench system in detail. During initial operations, it is anticipated that the system would be pumped at a flow rate of approximately 80 gpm with flows decreasing to a steady-state level in the range of approximately 30 to 55 gpm. (Revised January 30, 2015)

Segregation of Unimpacted Storm Water

The collection of leachate internal to the SLA described in the preceding section will prevent mixing of the leachate with storm water. ~~The runoff originates from upstream areas such as the recreation fields to the east of the SLA and the area located north of State Route 128. Although the existing collection and treatment system has been designed to reduce the mixing of storm water with the seepage, (e.g., via construction of the eastern drainage ditch bypass structure and the utilization of French drains along the eastern portion of the South Bench), additional evaluation of possible improvements to further segregation of seepage from unimpacted storm water is considered appropriate. Separation of these water sources will be particularly important for the new collection leg proposed along the railroad, given that this location receives runoff from a large area. Improvements to the Drainage Ditch may also be considered to separate unimpacted runoff from Seep 105 water and the diffuse groundwater discharge from the SLA. Possible improve¬ments consist of installing a cutoff trench to segregate seepage and/or installing a liner system in the bed of the Drainage Ditch to segregate seepage from unimpacted storm water runoff. Localized conveyances to route storm water off the surface of the SLA may also be appropriate to reduce long-term seepage generation rates.~~ **(Revised January 30, 2015)**

Western Slope Seep Conceptual Plan and Access Improvement

Consistent with Comment No. 7 in the Department's May 13, 2014 Comment Letter, ARCADIS has developed a conceptual plan that evaluates options for addressing the seeps that have been identified on the Western Slope. A copy of the conceptual plan is contained in Appendix X. This plan was also submitted to the Department on September 24, 2014. As described in the conceptual plan, ARCADIS evaluated several options for further managing the seeps on the Western Slope and selected the following options for proof of concept testing:

- **Installation of angled extraction wells from the top of the SLA that would have screened intervals at target depths for recovery of leachate in close proximity to location Seep 106**

- **Capture of the seeps at the point of discharge for conveyance to the wastewater treatment system for locations W-Seep and Seep 6**

- **Continued use of the passive mulch bed currently in place pending discontinuation of the IAS**

PPG is continuing to evaluate the implementability and efficacy of each of the above-listed options; the most suitable method for managing the seeps on the Western Slope will be selected and presented to the Department for approval. (Revised January 30, 2015)

Regardless of which of the above-listed options is selected, it will be necessary to improve access **to the Western Slope for implementation as well as operation and maintenance.** Access improvements for the **selected option** would involve construction of an access road to the floodplain (avoiding any stream crossings and construction in the floodway and floodplain of Glade Run). **Since 2012, improvements to** the access road on the top of the SLA ~~at a minimum~~ **have been made. (Revised January 30, 2015)**

Infiltration Reduction

ARCADIS has developed the Infiltration Reduction Conceptual Plan described in Appendix Y (previously submitted to the Department on September 24, 2014) that evaluates reducing infiltration through revegetating the remaining areas barren of vegetation to enhance evapotranspiration and by locally improving surface drainage on the upper surface of the SLA. Each of these methods of reducing infiltration will require minimal disturbance on the upper surface of the SLA. This approach is distinct from Infiltration Control as described in Section 8.3.4 in that it does not result in site-wide destruction of habitat, exposure of source material, substantial increase in leachate production during construction, or community and environmental impacts of importing very large fill quantities to the SLA. (Revised January 30, 2015)

Some very small patches barren of vegetation (generally a few tens of square feet in area) remain on the upper surface of the SLA. These barren areas will be identified and treated in the same manner as larger barren areas were during implementation of the IAP. Topsoil, likely amended with sulfur, will be placed on the barren areas and they will be seeded with a seed mixture conducive to thriving in the prepared seed bed. Establishing vegetative cover in these barren areas will enhance evapotranspiration on the SLA. (Revised January 30, 2015)

The vegetative cover will be further enhanced by planting selected species of vegetation that can thrive in the conditions existing within the SLA. Ideally, these vegetative species will have root systems with higher water uptake that can assist in reducing the quantity of water infiltrating into the SLA through higher transpiration rates. (Revised January 30, 2015)

Infiltration of precipitation and snow melt may be further reduced through the installation of a shallow interconnected drain system that follows topography to allow for gravity flow of water collected in the system. The drain system would generally be installed to a depth of approximately 6 inches bgs in selected areas as described in Appendix Y. The drains would be comprised of high-density polyethylene (HDPE) pipe embedded in coarse aggregate. Considering that the existing topsoil cover is relatively thin in most locations, the final extent and layout of the drain system will be designed to avoid encountering source material. To prevent contact of unimpacted storm water with source material, the trenches will be lined with synthetic liner material such as HDPE or PVC.

Point source storm water runoff from the infiltration reduction system will be properly routed to surface water bodies for discharge under the industrial NPDES permit that will be obtained. Management of storm water runoff in this manner is consistent with Comment No. 6 in the Department's May 13, 2014 Comment Letter and PPG's June 25, 2014 Response Letter. (Revised January 30, 2015)

The existing drainage channel along the south side of Route 128 will need to be refurbished by removing accumulated debris and reshaping the channel. The steel culvert that conveys runoff beneath the access road into the SLA will also need to be reinstalled so that water can be conveyed beneath the access road via gravity flow. These activities will need to be coordinated with local authorities. (Revised January 30, 2015)

Assuming that the above-listed conceptual alternatives are implemented, limited earth disturbance activities would occur. To identify areas where earth disturbance activities could have such impacts, wetland areas in particular, ARCADIS performed a wetland delineation of the upper SLA. This delineation, which was an update of the 2000 Key Environmental wetland delineation was performed in October 2014 and ARCADIS subsequently prepared the wetland delineation report that is contained in Appendix Y (Infiltration Reduction Conceptual Plan). Results of the wetland delineation will be utilized in planning earth disturbance activities associated with infiltration reduction. (Revised January 30, 2015)

8.3.3.2 Enhanced Neutralization Treatment System

Three remedial sub-alternatives for treating the seepage water were evaluated for the Enhanced Collection and Treatment remedial alternative. All three incorporate the enhancements to the ~~current~~ collection system described in Section 8.3.3.1 ~~by collecting seepage that is currently not captured by the existing collection system~~. The first sub-alternative discussed in this section (Existing Treatment System Upgrades) involves increasing the capacity and robustness of the existing treatment system by installing a permanent treatment facility and evaluating the need for other upgrades to the existing neutralization process, e.g., capacity. The second sub-alternative (Existing Treatment System Upgrades and Precipitation) is described in Section 8.3.3.3 of this Report and is a variation of the first that would incorporate a precipitation process into the treatment operations. The third sub-alternative is discussed in Section 8.3.3.4 of this Report, relies on further treatment, either on site or off site, and conveyance of the water collected from the seeps to a POTW for final treatment and discharge. ~~Each of these remedial sub-alternatives is discussed in this section.~~ **(Revised January 30, 2015)**

The first sub-alternative involves ~~making various upgrades~~ **installing a new neutralization system to replace** ~~to~~ the existing **IAS** treatment system to accommodate the additional flow from the expanded collection system. **The system would be designed to handle a flow rate up to 80 gpm, which is greater than the calculated average flow rate of 37 gpm from all of the seeps in the SLA. Designing the system to treat up to 80 gpm will meet the requirement of Comment No. 9 in the Department's May 13, 2014 Comment Letter.** The ~~minimum major improvements~~ **new system** would **neutralize the leachate collected in the interceptor trenches** ~~likely consist of increasing the pipe size from the existing junction box to the neutralization tank and modification to increase the capacity of the existing neutralization tankage. The capacity of the treatment tank would be at least doubled to provide greater retention time for pH adjustment. In addition, the locations of various portions of the treatment system would be evaluated to identify the best location for the expanded system~~**.** Placement of the treatment system on either the South Bench or on the SLA plateau near the existing acid storage tank would be evaluated, **but it is possible that the system would be installed on top of the SLA near the existing acid tank and the location of the pump station within the interceptor trench system**. The evaluation would also include determining the required size and location of a permanent building in which treatment equipment would be contained. Major design considerations for this component of the alternative include, but are not necessarily limited to, the following:

- Specification of transfer line materials, locations, lengths, and dimensions
- ~~Evaluation of the junction box capacity to accommodate increased flow~~
- Evaluation of acid delivery methods (micrometering valves versus feed pumps)
- Determination of friction losses and elevation head losses in new transfer lines

- Pump sizing ~~if~~ **for** lifting ~~of seepage~~ **leachate** to the treatment system ~~is deemed appropriate~~
- ~~Evaluation of the adequacy of the existing mixer and possible upgrades to the mixer(s)~~
- ~~Determination of an appropriate location to discharge treated seepage~~
- Specification of tankage (e.g., equalization, flash mix, and mixing tanks)
- Determination of appropriate tanks and inlet and outlet locations/elevations
- Evaluation of potential pressure and gravity flow system components
- Type, size, and location of a permanent building in which the treatment **system** would be contained
- **Constructing a new effluent line from the treatment system to convey treated leachate directly to the Allegheny River**

(Revised January 30, 2015)

The upgraded treatment system would be sited to accommodate long-term operation and maintenance, and the outfall works would be designed to facilitate routine effluent sampling. Design of the enhanced treatment system would be completed based on existing data to the extent possible. Collection of additional information may be necessary to support the final design. Input from the railroad would also likely be required for this component if a rail crossing is necessary for the effluent line and outfall works.

Enhancing the collection system as specified in Section 8.3.3.1 and the treatment system in accordance with the foregoing modifications is implementable. The above-described upgrades that would be made to the treatment system would be substantial, and the basic method of actively treating the water would continue to be neutralization. This sub-alternative would provide an incremental benefit in that heretofore uncaptured high pH seepage would be collected and neutralized. It would result in comprehensive attainment of the pH range specified by the Department as the interim discharge criteria (i.e., pH in the range of 6.0 to 9.0) and involve none of the additional long-term risks associated with other treatment alternatives. The capital cost of this alternative to collect and treat the ~~additional seepage~~ **leachate** is estimated to be in the range of $**2,500,000 to $3,200,000** with an annual operation, maintenance, and monitoring cost of **$125,000 to $200,000**. **(Revised January 30, 2015)**

During the construction, startup, and shakedown of the proposed treatment system, the IAS will continue to be operated until full efficacy of the treatment system has been demonstrated. (Revised January 30, 2015)

~~8.3.3.3 Precipitation Technology – Seep Water~~

~~The second sub-alternative under enhancing treatment of the collected seep water would involve installing a precipitation system to reduce the metals concentration in the seep water. This sub-alternative would likely incorporate the system improvements described in Section 8.3.3.2 of this Report for collecting and neutralizing the seep water prior to it undergoing the precipitation process.~~ **(Revised January 30, 2015)**

~~It is uncertain whether a precipitation process would be technologically or economically feasible given the unknowns related to the treatment process such as sludge generation rates, the high silica content of the seep water, management requirements, chemical consumption, and necessary unit operations. In theory, the precipitation process would incorporate the existing IAS to provide initial pH adjustment of the SLA seep water to a target pH of 8 prior to dosing with ferric chloride (or another suitable reagent) in a flash mix tank. The resultant precipitate would then be removed in a lamella clarifier and the supernatant would be subjected to final pH adjustment (if needed) before passing through sand filters for removal of any residual suspended solids. Treated water would then be discharged to the Allegheny River. The sludge from the bottom of the lamella clarifier would be pumped to a sludge thickener, dosed with a polymer, and dewatered using a filter press. The dewatered sludge would be transported to and disposed at an approved off-site facility.~~ **(Revised January 30, 2015)**

~~For a system with a nominal 50 gpm processing capacity, the estimated capital cost (consisting only of the components downstream of the existing IAS) is in the range of \$750,000 to \$2,250,000 including design, installation, and startup. This capital cost assumes that the enhancements to the collection and treatment system described in Sections 8.3.3.1 and 8.3.3.2 of this Report will be implemented regardless of whether metals precipitation is implemented. Therefore, the estimated \$750,000 to \$2,250,000 capital cost range for precipitation technology is in addition to the capital cost of the enhanced collection and treatment system (neutralization only). Annual operating and maintenance costs are estimated to be in the range of \$175,000 to \$375,000 per year, including projected sludge disposal costs.~~ **(Revised January 30, 2015)**

(Revised January 30, 2015)

8.3.3.3 Precipitation Technology - Interceptor Trench Leachate

An alternative to collecting and treating the leachate that emanates from the seeps using precipitation technology (in addition to neutralization) described in Section 8.3.3 would involve installing a precipitation system to reduce the metals concentration in the leachate that would be collected in the internal interceptor trenches. This Enhanced Collection and Treatment alternative would be comprised of a treatment system dedicated to the treatment of leachate collected from within the SLA or system improvements similar to those described in Section 8.3.3.2 of this Report for neutralizing the leachate prior to it undergoing the precipitation process. The system would be designed to handle a flow rate

up to 80 gpm, which is greater than the calculated average flow rate of 37 gpm from all of the seeps in the SLA. Designing the system to treat up to 80 gpm will meet the requirement of Comment No. 9 in the Department's May 13, 2014 Comment Letter. (Revised January 30, 2015)

The conceptual precipitation treatment system would be capable of treating up to 80 gpm of leachate that would be collected in the interceptor trenches. Actual treatment effectiveness is unknown given the uniqueness of the leachate, the custom design of the system, and the absence of full-scale experience. Treatment would begin by adding to the collected leachate a suitable salt solution in a reaction vessel. Salt-amended process water from the vessel would then flow to another reaction vessel where it would undergo pH adjustment to a suitable target pH prior to dosing with a coagulant. Polymer (if required) would be amended, and the process water would flow into a flocculation vessel and discharge into a conventional clarifier/thickener. The clarifier effluent will discharge to a NPDES-permitted outfall for direct discharge into the Allegheny River. The sludge from the bottom of the clarifier may be concentrated in a thickener (if required) and then dewatered through a filter press. The water obtained from the dewatering operation would be recycled into the treatment system for additional treatment, if required. The dewatered sludge would be transported to and disposed at an approved off-site facility. The precipitation technology described above is conceptual based on the treatability test results described in Section 7.4 of this Revised Report and will be further evaluated as part of the NPDES permitting process. (Revised January 30, 2015)

The capital cost of this alternative to collect and treat, including precipitation technology, is estimated to range from $4,300,000 to $5,650,000 to treat up to 80 gpm of leachate from the interceptor trenches. Annual operating and maintenance costs are estimated to be in the range of $700,000 to $1,200,000 per year, including projected sludge disposal costs. (Revised January 30, 2015)

During the construction, startup, and shakedown of the proposed treatment system, the IAS will continue to be operated until full efficacy of the treatment system has been demonstrated. (Revised January 30, 2015)

8.3.3.4 Conveyance of Seepage Water to a Publicly Owned Treatment Works

As an alternative to enhancing the existing collection and treatment with a permitted discharge to the Allegheny River, the seeps collected by the upgraded seep collection system would be conveyed to a POTW for subsequent final treatment and discharge. Most likely, the collected seeps would be conveyed by a new piping system to a local POTW. Under this sub-alternative, it is anticipated that the seepage captured by the enhanced collection system would be neutralized to a pH of between 6 and 9 standard units prior to being mixed with the other influent to the POTW. This neutralization could occur either at the POTW facility or at the SLA via completion of the Existing Treatment System upgrades sub-alternative.

This alternative would require installation of a piping and pumping system to convey the collected seepage to an existing system collection point or to the actual POTW plant location. Depending on which local POTW is utilized, one to four miles of pipeline installation would be required, at least some of which would be pressurized. The right-of-way considerations would have to be evaluated, and POTW-specific permitting considerations would have to be evaluated in substantive detail. A stream crossing may also be required, depending on which POTW accepts the water for final treatment and discharge.

However, such an approach has some substantial potential advantages which include cooperative utilization of system operation resources and the benefits of having final treatment and discharge occurring under an experienced, dedicated team that is already in place in the POTW organization. Because of the potential complexity of the administrative and permitting aspects of this remedial alternative, a full assessment would need to occur after a POTW is identified where the water could be conveyed for treatment. At this time, no arrangement has been made with any POTW to accept the water from the former SLA. Consequently, the implementability of this sub-alternative cannot yet be fully evaluated.

Major potential disadvantages for this alternative include the absence of availability of a POTW with excess capacity, the potential need for a stream or river crossing to reach the POTW, the steep terrain surrounding the SLA, the need for easements to cross lands owned by third parties, the potential for off-site releases in the event of pipe ruptures, and the availability of land for expansion of treatment capabilities if sited at the POTW.

The capital costs of this alternative consist of two primary components. The first is the construction (or expansion) of the neutralization system. This component is likely to be comparable in cost regardless of where the neutralization system is located and should be on the order of ~~$300,000~~ **$2,100,000** to ~~$500,000~~ **$2,500,000** as discussed in Section 8.3.3.2 of this Report. The second major capital cost will be the construction of the piping system and a pump house. The cost of this component is expected to range from ~~$320,000~~ **$1,200,000** to ~~$1,300,000~~ **$1,900,000** depending on the distance to the POTW (i.e., one to four miles). On-site neutralization system operation and maintenance costs for continuing on-site neutralization will be similar to those for the ~~Existing~~ **Enhanced Neutralization** Treatment System ~~Upgrade~~ option (i.e., approximately ~~$100,000~~ **$125,000** to **$200,000** per year). If an off-site treatment system is employed, costs for the on-site collection system operation and maintenance would be on the order of $50,000. Under both the on-site and off-site treatment alternatives, it is estimated that the POTW will charge a minimum of $10 per 1,000 gallons treated. For a nominal 50 gpm system, this equates to approximately $263,000 per year. The total capital costs of this alternative could range from

~~$620,000~~ **$3,300,000** to ~~$1,800,000~~ **$4,400,000** and the estimated annual operation and maintenance costs are expected to range from ~~$313,000~~ **$400,000** to ~~$363,000~~ **$500,000**. **(Revised January 30, 2015)**

8.3.3.5 Evaluation of Collection System Upgrades and General Site Improvements

After the Enhanced Collection and Treatment system has been installed, and after startup and shakedown has been completed, the entire system will be monitored and evaluated to determine the efficacy of the entire system. The following table shows the components of the Enhanced Collection and Treatment system that will be monitored and evaluated and the expected performance to demonstrate efficacy. (Revised January 30, 2015)

Enhanced Collection and Treatment System Element	Expected Performance to Demonstrate Efficacy
Internal interceptor Trenches	Leachate-impacted discharges cease at seep locations and along the Pittsburgh and Shawmut railroad tracks
Western Slope seep interception or collection	Leachate-impacted discharges cease at seep locations or seepage is effectively collected and conveyed for treatment
Infiltration control, revegetation, and enhanced transpiration through selective planting	Decrease in quantity of leachate collected in the interceptor trenches
Maintenance of storm water channel along south side of Route 128 and re-installation of culvert beneath access road	Run-on from Route 128 to the SLA is eliminated
Treatment system performance	Compliance with NPDES permit
Conveyance pipe to outfall at Allegheny River	Treated water is effectively being conveyed

(Revised January 30,2015)

Evaluation of the elements of the Enhanced Collection and Treatment system shown in the table above will begin after installation and will continue until such a time as the efficacy can be properly judged based on the performance of each element. (Revised January 30, 2015)

8.3.4 Infiltration Control through Regrading, Capping, or Phytoremediation

Notwithstanding the Enhanced Collection and Treatment system remedial alternatives discussed in Section 8.3.3 of this Revised Report, other remedial alternatives were considered, as further discussed in this section. The purpose of infiltration control is to reduce or eliminate seepage flows and thereby protect human health and ecological receptors. Three remedial alternatives that were evaluated to control infiltration include: regrading with surface water run-on and runoff controls, complete or partial capping of the former slurry lagoons, and a combination of regrading to establish surface water run-on and runoff controls and phytoremediation to decrease infiltration and increase transpiration. All three of these controls will minimize potential human health and ecological risks and reduce but not eliminate seepage from the SLA. **(Revised January 30, 2015)**

HELP model simulations were prepared to assess the seepage that would still occur through the SLA under regrading, capping, and phytoremediation schemes. Figure 17 is a graphic depiction and tabular summary of the HELP model results and the computer-generated output is contained in Appendix J. It should be noted that the final seepage rates predicted by the HELP model would occur over a period of approximately five years. The HELP model results are discussed below as they relate to the regrading, capping, and phytoremediation remedial alternatives.

8.3.4.1 Regrading

Regrading the top of the SLA would involve importing soil that would support vegetation, placing the soil so that the top of the SLA has an overall slope of three percent, and installing surface water drainage controls so that storm water runoff from the graded area is properly managed and discharged from the site. Figure 18 is a generalized final grading plan depicting the topographic contours that would result from placing soil over the entire SLA at a grade of three percent. This slope was selected because it improves runoff and is consistent with final grading requirements for residual waste landfills, as described in Title 25 Pennsylvania Code Chapter 288. The estimated quantity of soil that would be required for grading the top of the SLA is 280,000 cubic yards. Under the regrading remedial alternative, surface water runoff channels would be installed both on the perimeter of the SLA and within the final cover soil area to convey the runoff to the Allegheny River.

A HELP model simulation was constructed to determine reduction in seepage and groundwater recharge from regrading. As shown on Figure 17, the HELP model predicts that regrading the top of the SLA to the configuration shown on Figure 18 will result in total seepage reduction from an average of 34 gpm to 31.4 gpm over five years and groundwater recharge will be reduced from 7.8 gpm to 7.6 gpm over the same period. The estimated cost of regrading is $8,000,000 with an estimated annual operation and maintenance cost of $110,000.

8.3.4.2 Capping

Full and partial capping remedial alternatives are intended to be protective of human health and ecological receptors by isolating the source material and eliminating seepage or reducing the rate of it. Full capping of the former slurry lagoons would be performed in accordance with Chapter 288 and would include the following general activities:

- Preparation of the final grading plan and design drawings and documents including the Construction Quality Assurance and Quality Control Plan and Technical Specifications.

- A schematic of a final grading plan shown on Figure 18 is the same as the one for the regrading remedial alternative except a synthetic cap system would be installed at a depth of two feet bgs. Under this remedial alternative, final grades of three percent would be constructed, as required by Chapter 288.234. For a cap system installed over the entire SLA, the estimated quantity of fill that would have to be imported and placed to meet the minimum grades is approximately 280,000 cubic yards. This volume of soil includes the common fill to reach subbase final grades for the liner system and the required two feet of final cover soil.

- Installation of a textured high-density or textured linear low density polyethylene liner on top of the prepared subgrade. The liner would have a minimum thickness of 40 mils and an estimated 410,000 square yards would be required.

- Installation of a double-sided geocomposite drainage layer (410,000 square yards).

- Placement of two feet of final cover soil and revegetation of this soil.

- Installation of perimeter and interior storm water runoff channels to convey runoff to surface drainage (10,200 lineal feet).

As shown on Figure 17, the HELP model simulation predicts that capping the entire SLA would result in reducing the total seepage from an average of 34 gpm to an average of 3.0 gpm over five years and groundwater recharge would be reduced from 7.8 gpm to 3.3 gpm. Seepage would not be totally eliminated under the full capping remedial alternative; however, there would be a reduction in the volume of seepage that may still require collection and treatment.

Partial capping remedial alternatives were also evaluated to determine the reduction in seepage and groundwater recharge. The cap system for each of the partial capping schemes would be the same as the full cap scheme (synthetic liner, geocomposite drainage layer, and final cover soil) and perimeter drainage systems would be required to manage surface water runoff. In evaluating partial capping alternatives, the three groundwater drainage areas shown on Figures 15 and 16 were used as the basis for determining the areas to be capped. Four partial capping schemes were considered for the groundwater drainage areas, including the Western Bench (Figure 19), the South Bench and Drainage Ditch (Figure 20), the Western Slope and Drainage Ditch (Figure 21), and the South Bench (Figure 22). The four partial capping schemes are listed on the following table along with the quantity of fill that would be required, quantity of synthetic liner material, quantity of geocomposite material for the drainage layer, and length of storm water channels.

Groundwater Drainage Areas to be Capped	Quantity of Fill (cubic yards)	Quantity of Liner (square yards)(1)	Quantity of Geocomposite Material (square yards)(1)	Length of Storm Water Runoff Channels (lineal feet)
Western Slope	190,000	200,000	200,000	5,500
South Bench and Drainage Ditch	89,000	210,000	210,000	5,000
Western Slope and Drainage Ditch	200,000	250,000	250,000	8,400
South Bench	78,000	150,000	150,000	5,000

(1) Includes a 15 percent increase for overlap and waste.

HELP model simulations were constructed for the four partial capping schemes to predict seepage and groundwater recharge reduction. Results of the HELP model simulations for the above listed partial capping schemes are summarized in the following table.

Groundwater Drainage Areas to be Capped	Average Groundwater Drainage Area (acres)	Predicted Seepage Rate (gpm)	Percent Reduction	Predicted Groundwater Recharge Rate (gpm)	Percent Reduction
Western Slope	41.5	23.4	31	4.4	44
South Bench and Drainage Ditch	48.5	13.6	60	6.7	14
Western Slope and Drainage Ditch	56.5	16.1	53	4.2	46
South Bench	33.5	20.9	39	6.9	12

As shown on the table, the HELP model simulations predict that capping the groundwater drainage area that discharges to the Western Slope would reduce seepage from the SLA by about 31 percent but groundwater infiltration would be reduced by approximately 44 percent. Capping the groundwater drainage areas to the South Bench and Drainage Ditch would result in reducing the seepage rate by 60 percent and groundwater recharge by 14 percent. Capping the groundwater drainage areas to the Western Slope and the Drainage Ditch would result in reducing the seepage rate by 53 percent and the groundwater recharge rate by 46 percent. Finally, capping the groundwater drainage area to the South Bench would result in reducing the seepage rate by 39 percent and groundwater infiltration by 12 percent. The reductions in seepage rates would occur over a period of five years, as predicted by the HELP model. As with the full capping remedial alternative, partial capping would reduce the seepage rate and groundwater recharge rate from the SLA but seepage would still occur. Capital and annual operation and maintenance costs for the various capping schemes described above are summarized on the table in Section 8.3.5 of this report.

Comments Nos. 20, 21, and 22 in the Department's May 13, 2014 Comment Letter identified capping as a potential means of reducing infiltration and thus the quantity of leachate discharging at seep locations, and requested further discussion regarding the efficacy of such an approach. PPG addressed these issues in its June 25, 2014 Response Letter (Appendix Z); during discussion in the July 16 and October 27, 2014 meetings; and, in subsequent submittals regarding the Enhanced Collection and Treatment alternative, including installation of interceptor trenches. This included a discussion of the limited benefit associated with capping relative to the unwarranted site-wide destruction of habitat, exposure of source material, minimal surface risk, inability to eliminate leachate seeps, substantial increase in leachate production during construction, community and environmental impacts of importing very large fill quantities to the SLA, and cost. In light of these factors, the Department requested that PPG incorporate reasonable and practical measures to reduce infiltration as part of the enhanced collection alternative and indicated its concurrence that the Enhanced Collection and Treatment remedial alternative, including installation of interceptor trenches and reasonable practical measures to reduce infiltration, appears to be the most appropriate remedial approach. (Revised January 30, 2015)

8.3.4.3 Regrading and Phytoremediation

Phytoremediation can assist in reducing the seepage rate from the SLA by planting ground cover vegetation that develops root systems that have the ability to remove and transpire water at effective depths up to 24 inches below ground surface. Implementation of the phytoremediation remedial alternative would first involve grading the SLA as shown on Figure 18 to improve surface water runoff and decrease infiltration while minimizing the potential for erosion. Implementation of the phytoremediation remedial alternative would likely involve the use of stabilized sewage sludge to amend the soil and prepare a proper seedbed.

A HELP model simulation was constructed to predict the reduction in seepage rates through implementation of the phytoremediation remedial alternative. The results of the HELP model simulation are shown on Figure 17 and the computer-generated output is contained in Appendix J. The HELP model predicted the reduction in seepage, which is defined as the water remaining after the surface water that has infiltrated the surface has been removed by roots and ultimately evapotranspiration. By establishing 24 inches of root depth, the seepage rate would be reduced from 34 gpm under existing conditions to 31.6 gpm after phytoremediation is implemented, a change of approximately 7 percent and groundwater recharge would be reduced from 7.8 gpm to 7.6 gpm or about 2.5 percent (Figure 17). The capital cost of phytoremediation is estimated to be approximately $9,800,000.

8.3.4.4 Groundwater Diversion

Seepage from the SLA could be reduced by eliminating groundwater flux, which is groundwater that enters through glacial soil and bedrock on the northern boundary of the SLA. Intercepting groundwater on the northern side of the SLA would be accomplished by installing a deep groundwater cutoff drain between the SLA and State Route 128. The estimated length of the cutoff drain is 2,800 feet and the average depth is estimated to be 40 feet. The bottom of the cutoff trench for the drain would slope westward at one percent to provide gravity flow to daylight at ground surface at an elevation of about 850 feet msl. The southern wall of the trench would have a synthetic liner to act as a barrier to groundwater entering the SLA and as a barrier to leachate within the SLA entering the cutoff trench. The estimated cost of a groundwater cutoff drain is $4,500,000.

8.3.4.5 Evaluation of Infiltration Control Remedial Alternatives

The infiltration control remedial alternatives discussed above would mitigate long-term risks associated with direct contact with source material by placement of infiltration controls on top of the SLA. However, while infiltration control would result in reduced rates of seepage from the SLA, regardless of which remedial alternative is implemented, some seepage would continue to occur such that collection and treatment would have to continue. Installation of an infiltration control system would also require long-term maintenance and long-term monitoring to ensure that the integrity of the cover system is maintained.

Short-term risks associated with implementation of the various infiltration control remedial alternatives are associated with performing the work, including public safety and safety of the workers implementing the selected infiltration control scheme, as well as disruption to existing habitat and vegetative cover. Public safety is a significant concern because of the large volume of truck traffic that would occur along routes used for transporting material and equipment to the SLA.

The above-described infiltration controls would be relatively difficult to implement because they would require substantial effort and time to complete. The SLA currently has a well-developed vegetative cover and appears to be a significant wildlife habitat based on the casual sightings of large and small game, a variety of birds, and other animals. Moreover, the relatively level upper surface and grading that existed following closure of the former slurry lagoons provided conditions for the development of the wetlands as noted in the 1995 Baker Environmental “Feasibility Study for the PPG Ford City Site” and as identified by Ecological Restoration in 2001. Implementation of any infiltration control considered above would destroy the existing habitat by completely removing the existing vegetative cover and wetland areas in order to place fill for either enhancing surface water runoff or for installing a cap system. Implementing one of the infiltration controls described in this section will also require a substantial amount of time, on the order of one to three years.

Because significant seepage from the SLA would still occur, regrading, capping, and phytoremediation would not be any more protective of human health or the environment than either the Continued Collection and Treatment or Enhanced Collection and Treatment remedial alternatives.

8.3.5 Remedial Alternatives Cost Summary

Costs associated with implementing the remedial alternatives described in this section of the Report are summarized in the following table and are used for comparative purposes in the relative evaluation of the remedial alternatives using Act 2 Section 304(j) criteria described in Section 8.4 of this Report.

Table of Estimated Costs for Remedial Alternatives

	Remedial Alternative	Estimated Capital Cost	Estimated Annual Operation and Maintenance Cost
	No Further Action (Section 8.3.1)	$100,000[1]	NA[2]
	Continued Collection and Treatment (Section 8.3.2)	NA	$100,000[3]
Enhanced Collection and Treatment	Collection and Treatment System Upgrades -- Enhanced Neutralization Treatment System (Section 8.3.3.2)	~~$300,000 to $500,000~~ $2,500,000 to $3,200,000	~~$100,000~~ $125,000 to $200,000
	Collection and Treatment System Upgrades – Neutralization and Metals Treatment via Precipitation Technologies (Section 8.3.3.3)	~~$750,000 to $2,250,000~~ $4,300,000 to $5,650,000	~~$175,000 to $375,000~~ $700,000 to $1,200,000
	Collection and Treatment System Upgrades – Conveyance of Seep Water to a POTW (Section 8.3.3.4)	~~$620,000 to $1,800,000~~ $3,300,000 to $4,400,000	~~$350,000~~ $400,000 to $500,000
Infiltration Control	Regrading (Section 8.3.4.1)	$8,000,000	$110,000[3]
	Full Cap System (Section 8.3.4.2)	$14,500,000	$115,000[4]
	Partial Cap – Western Slope (Section 8.3.4.2)	$8,000,000	$115,000[4]
	Partial Cap – South Bench and Drainage Ditch (Section 8.3.4.2)	$6,100,000	$115,000[4]
	Partial Cap – Western Slope and Drainage Ditch (Section 8.3.4.2)	$9,300,000	$115,000[4]
	Partial Cap – South Bench (Section 8.3.4.2)	$4,800,000	$115,000[4]

	Remedial Alternative	Estimated Capital Cost	Estimated Annual Operation and Maintenance Cost
	Regrading and Phytoremediation (Section 8.3.4.3)	$9,800,000	$110,000(3)
	Groundwater Interceptor Drain (Section 8.3.4.4)	$4,500,000	NA

(1) One-time cost for decommissioning the existing treatment system.

(2) NA = Not applicable.

(3) Estimated annual cost of $10,000 to repair erosion rills and to maintain vegetative cover (fertilizer, over seeding, and revegetating barren areas) and for the operation of the Continued Collection and Treatment System remedial alternative.

(4) Estimated annual cost includes repairing erosion, maintaining vegetative cover (fertilizer, over seeding, and revegetating barren areas), mowing to prevent woody plants from becoming established, and operation of the collection and treatment system.

(Revised January 30, 2015)

8.3.6 Other Remediation Alternatives

Other remedial alternatives that were evaluated during previous investigations (D'Appolonia, 1971 and Baker Environmental, 1995) and remedial alternatives evaluated for this Report include:

1. Internal leachate collection via vertical wells, horizontal wells, and/or sumps to remove the leachate from within the former SLA
2. Beneficial reuse of the source material and seepage water
3. In situ treatment of leachate and the source material
4. Passive treatments using constructed wetlands
5. Ex-situ treatment
6. Excavate and dispose of the source material at a permitted waste disposal facility

Each of these remedial alternatives has been evaluated either by D'Appolonia, Baker Environmental, or ~~Shaw~~ **CB&I** and excluded from further consideration based on an evaluation of the Act 2 Section 304(j) criteria as they apply to each remedial alternative. Note that estimated costs are not provided for all of the remedial alternatives discussed below because some of them are either not considered effective or are not considered as a practical matter to be implementable. **(Revised January 30, 2015)**

Internal Leachate Collection by Recovery Wells

This remedial alternative would involve collecting the shallow groundwater (leachate) within the former slurry lagoons using a combination of horizontal and vertical wells and possibly groundwater sumps. The objective would be to manage the water discharging from the former slurry lagoons and lower the overall level of leachate. Horizontal wells could be installed through the perimeter dike walls at selected locations based on the results of groundwater modeling. The wells would communicate with the source material and provide an outlet for the leachate within the former slurry lagoons. Vertical wells and sumps would be installed in the interior of the former slurry lagoons to remove leachate. Considering the hydrologic characteristics of the source material and the overall areal extent of the SLA, approximately one-eighth square mile, the estimated number of vertical wells that would be required is in the range of 1,100 to 1,300 based on an effective drawdown radius of 25 feet. Leachate collected using this remedial alternative would be treated in the existing collection and neutralization system or an enhanced version of it prior to being discharged to surface water. This remedial alternative is best suited for use in combination with capping or partial capping to reduce infiltration and eventually minimize the quantity of water that would be collected and treated.

The most significant long-term risks associated with leachate collection using horizontal wells, vertical wells, or sumps or a combination of the three in association with the capping remedial alternatives include potential damage to the synthetic cap system and ineffectiveness of the recovery wells due to the hydrologic properties of the source material. A large number of cap penetrations would be required for vertical wells and sumps, which increases the likelihood of significant leakage through the liner at the pipe boots. Short-term risks would basically occur during installation of the wells when the drilling contractor's employees would be constantly exposed to the source material. Assuming that horizontal and vertical wells are able to lower the water table within the SLA and keep it lowered, there may be a significant reduction in the mobility and volume of regulated substances in the seeps; however, implementing this remedial alternative will be difficult because of the large number of wells that would be required and the pipe boots required to seal the wells to the liner system. As a guideline to estimating the number of wells that would require replacement, the Department's solid waste bonding forms indicate that costs must be included for replacing 10 percent of monitoring wells and gas extraction wells over the life of the post-closure period and 25 percent of the pumps. Assuming these criteria apply to replacing the leachate collection wells, more than 100 replacement wells and more than 300 replacement pumps would be required while the well field is being operated. Installation of new wells would require penetrating the synthetic cap system, adding additional long-term risks to this remedial alternative. This remedial alternative would be costly and the incremental health and economic benefits would be minimal compared to incremental health and economic costs. This remedial alternative provides no advantage to other collection and treatment alternatives.

Beneficial Reuse

A viable beneficial reuse of the source material has not been identified at this time. Beneficial reuse would involve excavation of the source material and/or collection of the seepage water and transportation to a project site where acidic materials or acidic water would be treated and neutralized. Considering the Act 2 Section 304(j) criteria, the excavation alternative would be difficult to implement because of the cost of excavating, transporting, and applying the source material at the beneficial use project site, even if it were determined that the proposed beneficial reuse is effective. Similarly, collecting and conveying seepage water would require construction of a pipeline to convey the water or maintaining a fleet of tanker trucks to transport the water to the beneficial use project site. Moreover, it would be necessary to demonstrate that the long-term risks associated with relocating the source material to the beneficial use project site should be minimal as would be determined from testing for the proposed beneficial reuse. Short-term risks could involve the health and safety of the contractor's employees excavating the source material and risks to the public from the increased traffic associated with transporting the source material to the beneficial reuse project. Removal of the source material would eliminate seepage from the SLA, thereby removing mobility, volume, and toxicity issues. Although a future beneficial reuse scenario may be identified, collection and treatment is likely to be continued in the interim until all of the source material has been removed.

In Situ Treatment of Leachate and the Source Material

In situ treatment of the leachate and source material would involve injecting chemicals into the source material to neutralize the leachate and/or the source material. Considering the Act 2 Section 304(j) criteria, the in situ leachate treatment remedial alternative is not considered implementable for several reasons. Long-term risks are generally related to the effectiveness of this remedial alternative. Groundwater in the source material moves under the influence of gravity via fracture flow, and there is no reasonable way to direct chemicals and control their movement so that they permeate all of the fractures and neutralize the water present within the fractures. Groundwater seepage into the source material is a continuous process so that in situ treatment would have to be ongoing in order to effectively treat the water. Therefore, uncertain and undetermined long-term risks associated with the methodology of this remedial alternative make the effectiveness of it questionable.

The uncertainty of the long-term risks and effectiveness of in situ treatment of leachate also makes the potential reduction of toxicity, mobility, and volume of regulated substance uncertain. In situ treatment of the leachate in the SLA would undoubtedly reduce the toxicity of the leachate but would likely have little impact on the mobility or volume of seepage that would occur after this remedial alternative is implemented. Short-term risks of in situ treatment generally relate to the health and safety issues of the contractor's workers during the in situ treatment process. As indicated above, in situ leachate treatment is considered a difficult remedial alternative to effectively implement, would likely be costly, and although there could be significant incremental health and economic benefits associated with neutralizing the leachate, when compared to the incremental health and economic costs associated with implementing in situ treatment, this remedial alternative is not considered viable.

In situ treatment of the source material would involve injecting chemicals and mixing them with the source material to obtain a homogeneous, neutralized mass that would remain in place after treatment is completed. A treatability study would be required to identify the chemicals that would be used to neutralize the source material, quantities required, efficacy of the treatment, and cost. Long-term risks associated with in situ treatment of the source material would be minimal if this remedial alternative could effectively neutralize all or the vast majority of the source material. In situ treatment would reduce the toxicity of the source material but seepage would likely still occur from the SLA, although the seepage should be effectively neutralized by the treatment of the source material. Short-term risks of in situ treatment generally relate to the health and safety issues of the contractor's workers during the in situ treatment process. In situ treatment of the source material is considered a difficult remedial alternative to effectively implement, would be very costly, and although there could be significant incremental health and economic benefits associated with treating the source material, when compared to the incremental health and economic costs associated with implementing in situ treatment, this remedial alternative is not considered viable.

Passive Treatment Using Constructed Wetlands

Passive treatment using wetland vegetation would involve collecting the seepage from the SLA and directing the flow through a constructed wetland area. Due to the high pH of the water, it is likely that pretreatment would be required to lower the pH to a value where wetland plants would thrive. Therefore, passive treatment alone in constructed wetlands should be considered as a remedial alternative that could be implemented in association with one or more of the other remedial alternatives. Success of constructed wetlands would require planting alkali-tolerant wetland plants. Wetlands would be constructed to have an outlet for the water passing through them and it is likely that an NPDES permit would be required for this constructed outlet. This approach could be considered as a supplementary treatment method to Enhanced Collection and Treatment. The objective of using constructed wetlands would be to reduce the volume of water that would have to be actively treated.

The long-term risks associated with this remedial alternative include the vitality and longevity of the constructed wetlands, the need to maintain the wetlands, and the possible need to neutralize the seepage water before it is discharged to the wetlands. Also, the amount of reduction in toxicity that would occur would have to be determined either through a pilot study or through long-term monitoring of the water discharging from the wetlands. Constructed wetlands could be a relatively easy remedial alternative to implement and would likely involve modifying existing wetland areas in the vicinity of the SLA. Constructed wetlands would likely be inexpensive relative to the costs of some of the other remedial alternatives, depending on the acreage of wetlands that would be needed. Operation and maintenance costs associated with this remedial alternative would primarily revolve around the system used to pretreat the seepage water before it is discharged into the constructed wetlands. No significant incremental health and economic benefits would occur compared to the incremental health and economic costs associated with implementing constructed wetlands as the remedial alternative because neutralization and direct discharge of seepage water under an NPDES permit could occur under the Enhanced Collection and Treatment remedial alternative without routing the treated water through constructed wetlands. Constructed wetlands would be no more protective of human health and the environment than the human health and environmental benefits already being realized in the constructed mulch beds and naturally occurring wetlands.

Ex-Situ Treatment

The ex-situ treatment remedial alternative would involve exhuming the source material, mixing with chemicals, and placing the material back into the SLA. A treatability study would be required to identify the chemicals that would be used to neutralize the source material, quantities required, efficacy of the treatment, and cost. The Department would likely require a permit to process residual waste and the processed source material may still be a residual waste after processing and placed back in the SLA. A permit by rule or a solid waste landfill permit issued pursuant to Chapter 288 may be required. The solid waste permit would involve installation of a composite liner system in the former slurry lagoons, in which case the Department may not issue a permit if the required separation distance does not exist between the bottom of the liner system and the regional groundwater table.

Long-term risks associated with ex-situ treatment would be minimal because the source material would be completely removed, thoroughly treated, and then placed back in the SLA. Ex-situ treatment would minimize the toxicity of the source and immobilize the constituent of concern in the source material. Short-term risks of ex-situ treatment generally relate to the health and safety issues of the contractor's workers during the ex-situ treatment process. Ex-situ treatment of the source material is considered a difficult remedial alternative to effectively implement, would take a very long time to implement, would be very costly, and will not address secondary seeps. When compared to the incremental health and economic costs associated with implementing in situ treatment, this remedial alternative is not considered viable.

Excavate and Dispose of the Source Material at a Permitted Waste Disposal Facility

This remedial alternative would involve excavating the source material and transporting it to a permitted waste disposal facility. The quantity of source material that would require off-site disposal is estimated to be approximately 3,000,000 tons. Long-term risks at the site would be reduced or eliminated because all of the source material would be removed from the SLA; however, this remedial alternative would only transfer toxicity, mobility, and volume issues related to the source material to another location. Short-term risks include health and safety of contractor's employees excavating the source material and risks to public safety on roadways used by vehicles to transport the source material to a solid waste disposal facility. Disposal capacity of the solid waste disposal facility could also be a significant issue. An estimated 150,000 truckloads of source material would be transported off site. Significant health and economic benefits would not be realized by implementing this remedial alternative because the source material would be removed and disposed at another location which would require its own controls. There are no significant incremental health and economic cost benefits to this remedial alternate to justify its implementation.

8.4 Relative Evaluation of Remedial Alternatives with Act 2 Section 304(j) Criteria and Recommended Remedial Alternative

As described in Section 8.1 of this Report, essentially one RAO remains to be addressed in order to comply with the Performance Obligations of the AO. This RAO, which is also listed in Section 8.1 of this Report is as follows:

"Collect and convey industrial waste discharges, leachate, and seeps to an industrial waste treatment facility. Discharge of the treated water to waters of the Commonwealth is currently authorized pursuant to the Department's July 2, 2009 letter approving the IAP; however, upon approval of this Report and implementation of the recommended remedial alternative, discharge will be authorized under an NPDES permit."

This section of the report contains a relative evaluation of the remedial alternatives that were described in Section 8.0 of the Report with respect to their ability to comply with the RAO and with respect to their relative ranking using the Act 2 Section 304(j) screening criteria. Evaluation of the remedial alternatives is a requirement of the approved Treatment Plan prepared by ~~Shaw~~**CB&I** (June 2009). This relative evaluation provides the basis for selecting the most suitable remedial alternative that will meet the RAO. **(Revised January 30, 2015)**

The following table ranks the Act 2 Section 304(j) screening criteria as they apply to each remedial alternative. The table uses a simple numerical ranking system based on a scale of 1 through 4 with 1 representing Poor, 2 representing Fair, 3 representing Good, and 4 representing Very Good. The numerical ranking also assumes that all of the Act 2 Section 304(j) screening criteria are of equivalent importance. The table was prepared based on the evaluations of the various remedial alternatives described in Section 8.3 of this Report and the numerical values assigned are based on professional judgment.

Relative Evaluation of Remedial Alternatives

Remedial Alternative	Act 2 Section 304(j) Evaluation Criteria						
	Long-Term Risks and Effectiveness	Reduction of Toxicity Mobility or Volume of Regulated Substances	Short-Term Risks and Effectiveness	Ease or Difficulty of Implemen-tation	Cost	Incremental Health and Economic Benefits vs. Incremental Health and Economic Costs	Total Score
No Further Action (Section 8.3.1)	2	1	2	4	4	2	15
Continued Collection and Treatment (Section 8.3.2)	3	3	3	4	4	4 (1)	21
Enhanced ~~Collection and~~ Neutralization Treatment System (2) ~~– Neutralilzation Only~~ (Section 8.3.3.2).	4	4	4	3	3	4 (1)	22
Enhanced Collection and Treatment – Neutralization and Metals Treatment Via Precipitation Technologies (2) (Section 8.3.3.3)	~~3~~4	4	~~3~~4	2	2	3(1)	1~~7~~9
Enhanced Collection and Treatment – Conveyance and Treatment at a POTW (2) (Section 8.3.3.4)	3	4	4	1	2	3	17
Leaching Control (Grading, Capping & Phytoremediation) (Section 8.3.4.1 through 8.3.4.3)	3	2	2	2	1	1 (1)	11
Groundwater Interceptor Drain (Section 8.3.4.4)	3	2	2	1	1	2	13
Internal Leachate Collection via Wells and/or Sumps (Section8.3.4.5)	3	4	2	2	1	1 (1)	13
Beneficial Reuse (Section 8.3.6)	3	4	1	1	2	1	12
In-Situ Treatment of Leachate and Source Material (Section 8.3.6)	3	3	2	1	1	1 (1)	11
Passive Treatment Using Constructed Wetlands (Section 8.3.6)	3	2	3	4	3	3 (1)	18

Remedial Alternative	Act 2 Section 304(j) Evaluation Criteria						
	Long-Term Risks and Effectiveness	Reduction of Toxicity Mobility or Volume of Regulated Substances	Short-Term Risks and Effectiveness	Ease or Difficulty of Implementation	Cost	Incremental Health and Economic Benefits vs. Incremental Health and Economic Costs	Total Score
Ex-Situ Treatment (Section 8.3.6)	4	4	1	1	1	1	12
Excavate and Dispose Source Material (Section 8.3.6)	4	4	1	1	1	1	12

(1) *Updated restrictive covenants under Act 68 will ~~remain in place~~ be included.*

(2) *Alternative includes infiltration reduction and vegetation improvements proposed.*

KEY:		
	4	Very Good
	3	Good
	2	Fair
	1	Poor

Based on the Department's comments in the May 13, 2014 Comment Letter and PPG's June 25, 2014 Response Letter and follow-up communications with the Department (Appendix Z), the Enhanced Collection and Treatment remedial alternative evaluated in the table above is the most appropriate alternative. (Revised January 30, 2015)

The numerical ranking results shown on the table identify the remedial alternative with the highest numerical rank relative to the other remedial alternatives. The highest ranked remedial alternative is judged to be one that ranks highest considering the Act 2 Section 304(j) relative screening criteria. Enhanced Collection and Treatment involving only neutralization attained the highest score relative to the other remedial alternatives and Continued Collection and Treatment had the second highest score.

~~As described in Section 8.3.3.3 of this Report, the Enhanced Collection and Treatment remedial alternative involves collecting additional seepage, primarily along the Pittsburgh and Shawmut Railroad tracks and possibly on the eastern end of the South Bench, and conveying these waters to the treatment system, upgrading the treatment system to manage the increased volume of water, improving access to the Western Slope, and segregating seepage water in the Drainage Ditch from unimpacted storm water runoff. This remedial alternative would continue the existing treatment method of neutralizing the water and discharging it to the Allegheny River.~~ **(Revised January 30, 2015)**

Sections 8.3.3.1 through 8.3.3.3 of this report describe the Enhanced Collection and Treatment remedial alternative that is comprised of installing internal interceptor trenches

on top of the SLA to collect leachate within the SLA; eliminating or collecting the seepage on the Western Slope via angled wells or collection at the seep locations and conveyance for treatment; and infiltration control via installation of drains on top of the SLA, revegetating areas barren of vegetation, and planting selected vegetation to enhance evapotranspiration. Consideration was also given to precipitating metals in addition to neutralizing the ~~seep water~~ **leachate that would be collected in the interceptor trenches and on the Western Slope. As** discussed in Sections 6.0 and 7.0 of this Report, given the neutralized discharges favorable comparability to technology-based standards as well as current compliance with WQBELs, **the need for** further treatment ~~of the discharge is not warranted~~ **is questionable**. **The extent to which there is a need for treatment beyond that which is currently provided in the IAS will be further evaluated in the NPDES permitting process.** Enhancing the collection and treatment system and continued neutralization is consistent with the RAOs and would result in an overall significant incremental health and economic benefit compared to the incremental health and economic cost. The Continued Collection and Treatment remedial alternative described in Section 8.3.2 of this Report consists of continuing the operation of the existing collection and treatment system with no upgrades to collect and treat additional seeps. **(Revised January 30, 2015)**

Based on the relative evaluation of the remedial alternatives summarized on the table above, Enhanced Collection and Treatment is the recommended remedial alternative.

8.5 Implementation Sequence

The general sequence for implementation of the above-described Enhanced Collection and Treatment system evaluated by ARCADIS in 2014, subject to receipt of pertinent permits and authorizations, will be as follows:

- **Continue to operate the IASInstall the interceptor trenches on the interior of the SLA**
- **Complete assessment and install the selected remedial measures to eliminate or collect leachate-impacted seeps on the Western Slope**
- **Complete assessment and install the infiltration reduction system on top of the SLA, revegetate areas barren of vegetation, and plant selected vegetative species to enhance evapotranspiration**
- **Conduct possible pilot study using leachate for the selected treatment technology**
- **Install treatment system and new pipe from the treatment system to the Allegheny River as a discrete conveyance for treated leachate**
- **Start-up and shakedown of the Enhanced Collection and Treatment system**

- **Decommission the IAS after the efficacy of the Enhanced Collection and Treatment system has been demonstrated**
- **(Revised January 30, 2015)**

9.0 Required Permits and Approvals and Implementation Schedule

Permits and approvals for implementing the recommended remedial alternative are described in this section.

Title 25 Pennsylvania Code Chapter 92 – National Pollutant Discharge Elimination System Permitting, Monitoring and Compliance

PPG will submit a NPDES permit application to the Department by March 31, 2015. The NPDES permit would replace the current AO discharge authorization and would be required for the discharge of water that may be treated in the Enhanced Collection and Treatment system. The NPDES permit would establish permit conditions and discharge criteria for the treated water. In association with the NPDES permit, a Water Quality Management Permit would be required for the Enhanced Collection and Treatment system. This permit would include the application; Design Engineer's Report; Preparedness, Prevention, and Contingency Plan; and other supporting information. Both of these permits would be issued by the Department's Bureau of Water Management. ~~The NPDES permit application would be submitted approximately six months after both the recommended remedial alternative is approved by the Department and approval to work on the railroad property is obtained from the Pittsburgh and Shawmut Railroad.~~ The Water Quality Management permit application would be submitted approximately three months after receiving the NPDES permit. **(Revised January 30, 2015)**

Title 25 Pennsylvania Code Chapter 102 – Erosion and Sedimentation Control

Earth disturbances associated with implementation of the selected remedial alternative would require implementation of erosion and sedimentation controls. If there is less than one acre of disturbance associated with implementation of the selected remedial alternative, a written erosion and sedimentation pollution control plan (E&S plan) is required. If there is more than one acre of earth disturbance, a General NPDES permit for storm water discharges associated with construction activity would be required. This permit and the associated E&S plan would normally be issued by the Armstrong Conservation District; however, given that this is a remediation project, the Department may take jurisdiction and the issue the NPDES permit, if one is required. Assuming that the Enhanced Collection and Treatment remedial alternative is approved by the Department, the E&S plan would be included with the plans for upgrading the existing collection and treatment system. These plans would be submitted approximately six months after the Department approves the recommended remedial alternative.

Title 25 Chapter 105 – Dam Safety and Waterway Management and U.S. Army Corps of Engineers Section 404

Should implementation of the selected remedial alternative involve obstructing or encroaching on any wetlands or waters of the Commonwealth, it may be necessary to obtain a joint, nationwide permit or a general permit issued by the Department and/or the USACE if the activity is not waived by regulation or as a result of this project being for remediation. Such encroachments are likely to be associated with **the discharge pipe to the Allegheny River** ~~collecting the seeps along the Pittsburgh and Shawmut Railroad tracks~~ **as part of the SLA surface proposed drainage system** or in the Drainage Ditch. If it is determined that water obstruction and encroachment will be required as part of the remedial alternative implementation, the appropriate application will be prepared and submitted to the Department's Watershed Management section and the USACE 9 to 12 months before the encroachment activities would occur. **(Revised January 30, 2015)**

Title 25 Pennsylvania Code Chapter 287 – Residual Waste Management

Assuming that the selected remedial alternative does not involved processing or placing the source material back into the SLA, no permitting should be required under Chapter 287. However, any material that could be construed as being residual waste that is encountered during the implementation of the selected remedial alternative will be managed in accordance with the residual waste management regulations.

Title 40 Code of Federal Regulations Parts 350 through 372 – Emergency Planning and Community Right-to-Know

If enhancement of the existing collection and treatment system requires increasing the quantity of sulfuric acid or the use of another hazardous substance or substances, it would be necessary to amend the Tier II Emergency and Hazardous Chemical Inventory that is currently on file with the Department of Labor and Industry, Armstrong County, and the West Kittanning Fire Department.

Other Permits and Approvals

Other permits and approvals that may be needed include, but are not limited to, zoning and local construction permits from Cadogan or North Buffalo townships, permission from the landowner to enter and work on the property, permission from Pittsburgh and Shawmut Railroad to perform work within their right-of-way or property, permission from the Pennsylvania Department of Transportation to work within their right-of-way, and permission from other property owners to enter their property.

General Implementation Schedule

Permit applications will be submitted and the selected remedial alternative will be implemented in accordance with the following general schedule:

Proposed Implementation Schedule

Activity	Estimated Completion Date
Prepare National Pollutant Discharge Elimination System permit application	March 31, 2015
Prepare and submit other permit applications	6 months after receipt of written approval of the Revised Treatment Plan Report and procuring the right to enter and work on properties
Begin construction of the Enhanced Collection and Treatment system	30 days after receipt of all permits, subject to procurement considerations and weather conditions
Complete construction of the Enhanced Collection and Treatment system and begin operation	180 days after receipt of all permits, subject to procurement considerations, property access, and weather conditions

(Revised January 30, 2015)

10.0 Conclusions and Recommendations

As described in this Report, the identified data gaps have been addressed during the implementation of the Treatment Plan. **Supplemental data collection activities and development of conceptual designs have been undertaken by ARCADIS since the Report submittal in 2012 to further refine the remedial approaches. The Enhanced Collection and Treatment system remedial alternative further evaluated and the conceptual designs developed by ARCADIS are included in this Revised Report. The conclusions and recommendations presented below have also been revised to reflect the comments in the Department's May 13, 2014 Comment Letter and PPG's responses to the Department's comments contained in the June 25, 2014 Response Letter and follow-up interactions with the Department.** The conceptual site hydrologic model has been refined and remedial alternatives have been evaluated in the context of the **Remedial Action Objectives** (RAOs). The following conclusions and recommendations are presented based on the information presented and discussed in this Report. **(Revised January 30, 2015)**

10.1 Conclusions

- PPG has prepared this Treatment Plan Report in compliance with the Performance Obligations of the **Administrative Order** (AO) and the Department-approved Treatment Plan.

- Previous risk assessments performed for the **Slurry Lagoon Area** (SLA) have concluded that there is no unacceptable risk to human health ~~and these conclusions remain valid~~ **n**or **will there be unacceptable risks to** ecological receptors. **(Revised January 30, 2015)**

- The **Interim Abatement System** (IAS), which became operational in early 2010, has been effectively treating seepage water both through chemical treatment and through passive treatment. Evaluation of the information obtained during the implementation of the Treatment Plan to address the identified data gaps has resulted in the development of a thorough understanding of the geomorphology of the former slurry lagoons and surrounding area, the chemistry of the source material, chemistry of ponded water on top of the former slurry lagoons and surface water runoff from the SLA, chemistry of water in the Allegheny River and Glade Run, and the chemistry of secondary source materials (talus). The information obtained during **and following** implementation of the Treatment Plan was used to develop a comprehensive conceptual site model that subsequently formed the basis of evaluating remedial alternatives. **(Revised January 30, 2015)**

- Four groundwater systems have been identified in the vicinity of the SLA, three of which are hydrologically connected. Shallow groundwater is present in the SLA, in the glacial soil on the northeastern corner of the SLA, and in the alluvium along the Allegheny River**,** and regional groundwater is present in bedrock. Of these four groundwater systems, groundwater in the glacial soil and regional groundwater in bedrock provide recharge to the SLA, and thus, they are hydrologically connected to it. The alluvium is not hydrologically connected to the glacial soil, bedrock in the immediate SLA, or to the SLA.

- Seepage from the SLA occurs at multiple locations. The source of the seepage is infiltration of storm water and groundwater in the glacial soil and bedrock. The average total combined seepage rate for all the seeps is 37 gpm. This seepage rate represents seepage that occurs during the normal hydrologic cycle and includes runoff that mixes with the seepage water at some of the seep locations during rain events and low seepage flow conditions that occur during extended dry periods. Groundwater flow within the SLA is believed to be controlled by fractures that have developed in the weakly cemented source material.

- Groundwater in bedrock north of the SLA flows southeastward toward the Allegheny River and provides recharge to the ~~shallow groundwater~~ **leachate** system within the SLA. Based on a review of chemistry information for groundwater in bedrock compiled by Baker Environmental **and supported by results of the two bedrock wells (MW-20 and MW-21) installed and monitored on the eastern side of the South Bench in 2014**, ~~Shaw~~**CB&I** concludes that there have been no adverse impacts to groundwater in bedrock from the source material within the former slurry lagoons. **Furthermore, results of new bedrock Wells MW-20 and MW-21 support the conclusion that the water expressing itself as seeps from the outcrop above the railroad tracks predominantly reflects impacted groundwater in the overburden material and not the presence of leachate and seepage in deeper bedrock. (Revised January 30, 2015)**

- An evaluation was performed of the impact to the Allegheny River of the water from Seep 5 and the treated seep water discharging from Outfall 001 using WQBELs established by constructing PENTOXSD model runs. The results of the modeling indicate that the respective WQBELs are significantly higher than the potential metals concentrations. The discharge from the site does not result in exceedances of relevant **Water Quality Criteria** (WQC). The magnitude of these differences alleviates concerns that any of the identified WQC would be jeopardized from the current quality of the discharge, even when a **Factor of Safety** (FOS) in the range of 20 percent to 50 percent is considered. **PPG understands the Department may perform its own modeling during the NPDES permitting process, as indicated in Comment No. 2 in the Department's May 13, 2014 Comment Letter. (Revised January 30, 2015)**

- The SLA activities are not directly associated with industrial categories for which published technology-based **Effluent Limitation Guidelines** (ELGs) exist. ~~Under the current setting, the most comparative and logical form of technology-based effluent limitations emerged from the USEPA-developed RGP.~~

- ~~The quality of the neutralized discharge water is well within the WQBELs and meets comparable technology-based standards such that additional treatment of seep water is not warranted.~~

- Technologies evaluated as part of the treatability testing efforts have led to the conclusion that the SLA seep water matrix is not amenable to treatment via adsorptive media (for both technical and economic reasons). Precipitation may hold merit but **required** further refinement to identify and evaluate precipitation methods that may be applied to the seep water **or groundwater** and to move past assumptions and professional judgment. **PPG has moved forward with additional treatability testing to further evaluate the efficacy of precipitation-based treatment. However, t**he current treatment afforded by the IAS results in a discharge that is fully protective of water quality and contains metals at concentrations that already meet comparable federal ELGs as used in the context of the RGP-prescribed remediation discharge standards. **Effluent limits will be established as part of the NPDES permitting process. (Revised January 30, 2015)**

- Four viable remedial alternatives were evaluated with respect to the RAOs. These alternatives were evaluated relative to one another using the Act 2 Section 304(j) screening criteria, and a numerical ranking system was developed as shown on the table in Section 8.4 of this Report. Six additional remedial alternatives were also evaluated relative to one another with respect to the RAOs but are not considered viable because they scored significantly lower using the ranking system in Section 8.4 compared to the Act 2 Section 304(j) screening criteria. The four viable remedial alternatives include No Further Action; Continued Collection and Treatment; Enhanced Collection and Treatment; and Infiltration Control through Capping, including installation of a groundwater interceptor drain. Based on the relative evaluations of these four remedial alternatives with respect to one another using the Act 2 Section 304(j) screening criteria, Enhanced Collection and Treatment achieved the highest numerical ranking, as shown on the table in Section 8.4 of this Report, is considered the best remedial alternative to achieve the RAOs, and therefore, is the recommended remedial alternative.

- ~~The Enhanced Collection and Treatment remedial alternative includes maintaining the existing seep collection and treatment system and more robust collection and treatment of other seepage. Segregating and collecting/treating the flow from Seep 105 and groundwater discharging from the SLA into the Drainage Ditch, collecting and treating the seepage from the shale and sandy shale rock outcrop adjacent to the Pittsburgh and Shawmut Railroad tracks, and improving access to the Western Slope area so that the mulch bed in that area could be appropriately maintained will be significant improvements to the collection system in the area of the SLA.~~ **Supplemental investigative activities were initiated by ARCADIS in February 2014 to refine the conceptual site model and to further evaluate the Enhanced Collection and Treatment remedial alternative recommended in the December 2012 edition of this Report. As a result of these activities, use of an interceptor trench completed internal to the SLA along the southern and eastern boundaries of the SLA along with collection or elimination of seeps on the Western Slope and reducing infiltration on top of the SLA are the recommended method for Enhanced Collection and Treatment. The effective completion of this Enhanced Collection and Treatment remedial alternative will dewater the leachate**

accumulated in the SLA adjacent to the eastern and western berms, thus eliminating the leachate-impacted seeps. (Revised January 30, 2015)

- **The results obtained from the three phases of supplemental bench-scale treatability testing completed in 2014 provide additional insight regarding overall leachate chemistry at the site and the effectiveness of precipitation technologies. (Revised January 30, 2015).**

- **An NPDES permit will be required for the discharge of water collected and treated in the Enhanced Collection and Treatment system and the extent to which there is a need for treatment beyond that which is currently provided in the IAS will be further evaluated in the NPDES permitting process.**

(Revised January 30, 2015)

10.2 Recommendations

The following recommendations are based on the ~~conclusions presented in Section 10.1 of this Report~~ **remedial alternative evaluations presented in this Revised Report:**

- Prepare and submit necessary permit applications or requests for approval to the appropriate agencies and other relevant parties in advance of the implementation of the recommended remedial alternative. **The NPDES permit application will be submitted to the Department by March 31, 2015.**

- **Update the existing deed restrictions by executing environmental covenants in accordance with Pennsylvania Act 68.**

- **Further assess the appropriate option for eliminating the seeps on the Western Slope.**

- **Further assess precipitation infiltration reduction methods for the SLA.**

- Implement the ~~first sub-alternative described~~ Enhanced Collection and Treatment remedial alternative as presented in Section**s** 8.3.3**.1 through 8.3.3.3** of this **Revised** Report. This alternative includes ~~enhancing~~ **continuing to operate the existing** ~~the~~ seep collection system **(as needed), installation of an interceptor trench for collection of leachate internal to the SLA, and implementation of the selected options for the Western Slope and precipitation infiltration reduction**.

- **Complete the geotechnical engineering investigation designed to evaluate the stability of the eastern, southern, and western berms and install instrumentation to monitor these slopes during installation and implementation of the Enhanced Collection and Treatment remedial alternative.**

- **Conduct additional treatability testing, if warranted, by the NPDES application process.**

- **A pilot test for the treatment system may be required, if warranted, by the NPDES application process.**
- **Construct treatment system, including start-up, shakedown, and achieve steady-state operation, consistent with the outcome of the NPDES application process.**
- **Decommission the IAS after the efficacy of the Enhanced Collection and Treatment system has been demonstrated.**

(Revised January 30, 2015)

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